

# **ANNALS of SURGERY**

# A Monthly Review of Surgical Science and Practice

### **Edited by**

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of New York

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# ANNALS of SURGERY

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## POSSIBLE ADVANCES IN CIVIL MEDICINE SUGGESTED BY EXPERIENCES IN TREATING WAR INJURIES OF THE CHEST\*

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THE war taught anew and emphasized as it has never before been emphasized that successful treatment entails more than preventing an immediate fatality. The other elements to be considered are the preservation of normal local and general function, reduction in the duration of disability and protection from increased liability to subsequent disease. From this viewpoint diseases of the chest present opportunities for therapeutic progress and for wide service, the equal of those offered by the rest of the body.

Preservation of the structural and functional integrity of the pleural cavity is the chief objective in medical and surgical treatment of pleuro-pulmonary disease or injury. This is to be achieved through the restitution of mobility of the thoracic parietes, of intrapleural negative pressure and of pulmonary elasticity. Under these conditions normal respiration and pulmonary circulation are possible, and only under these conditions can occur the sudden and wide compensatory variations required by the fluctuating activities of ordinary life.

The most important feature in both medical and surgical therapy is the prevention and relief of pleurisy. Pleurisy is the commonest indication for treatment, the most frequent cause of failure of intrathoracic operations undertaken to relieve other diseases, and, if uncontrolled, it leads to serious and often to permanent impairment of parietal mobility, intrapleural negative pressure, and pulmonary elasticity—hence to some degree of incapacity.

Pleural reactions to irritation should be considered from two angles: First, the local and general effects common to serositis, and second, the specific effects peculiar to pleurisy.

*Serositis* is characterized by an abundant sero-fibrinous exudate and a tendency to the formation of adhesions between contiguous surfaces. Both the profuse exudate and the adhesions are natural defensive reac-

\* Read by title before the American Surgical Association, June, 1919.

† The work upon which the communication is based has been generously assisted by the Research Division, American Red Cross, under the direction of Dr. Alexander Lambert.

tions, both are inevitable steps in repair, and, if uncontrolled, either may exert unfavorable influences upon ultimate recovery. An early formation of adhesions is desirable to bottle up an area of irritation, to enmesh bacteria and thus to restrict a dissemination of irritants while local and general resistance are being developed. The earliest subsequent elimination of these adhesions is desirable, and can be influenced by treatment. Adhesions are eliminated by being so gradually disrupted that the denudations produced are immediately overgrown with serosa cells. Excessive disrupting force by causing too great mechanical irritation serves to aggravate the existing lesions. Adequate force is best supplied by active motion which is controlled by reflex pain inhibition. Fibrinous adhesions are formed in four to eight hours, and their organization is definite in three to four days. The most favorable time to begin active motion is when the dangers of acute infection are passed, so that the possible liberation of bacteria through tearing adhesions may be tolerated. These facts have been recognized in methods of treating peritonitis. Willem's<sup>1</sup> and Delrez<sup>2</sup> have proved they are applicable to arthritis, and they hold equally well in pleurisy.

The effects of the serous exudate, which is always profuse, are determined by the rapidity of absorption. In the belly where absorption is so rapid as to amount almost to perfect drainage, there is little accumulation about or diffusion from the primary focus of reaction, but there is danger of over-intoxication. In the synovial and pleural cavities accumulation of excess exudate is the rule because of a low rate of absorption. The lesser dangers of immediate intoxication are more than compensated by disadvantages. Accumulation of a fluid within a cavity means hypertension and a corresponding anaemia, the separation of serous surfaces assures lessened resistance and greater diffusion. Serous exudates usually contain some of the original irritant and are therefore dangerous, but even though they contain none, they are of themselves sufficiently irritating to induce a similar though less active sero-fibrinous reaction on normal serous surfaces to which they are diffused.

The anatomic reaction of all serous surfaces is quite identical, the serosa cells exhibiting remarkably high powers of resistance and regeneration. Consequently, the explanation for the variations in resistance of different serous cavities is clear. In general, the larger the cavity, the more adaptable its walls, the richer the blood supply of its limiting membranes, particularly the visceral deflection, the more rapid the absorption, and the higher the resistance. Natural methods of defense show the peritoneal cavity which spontaneously prevents the separation of serous surfaces has the highest resistance. Clinical methods which prevent this separation of serous surfaces, or if separation has occurred, produce a reapposition of these surfaces, offer the optimum opportunities for recovery. Artificial drainage, introduced so as to imitate physiological absorption, is required.

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The specific effects of pleuritic reactions upon parietal mobility, intrapleural negative pressure, and pulmonary elasticity are equally positive indications for relief.

*Parietal Mobility.*—Assuming integrity of bones, joints, and cartilages normal motion in the chest parietes depends upon unimpaired function of the muscle-nerve combinations concerned in producing inspiration.

Acute pleurisy causes a prompt inhibition of motion in the elevators of the ribs and in the diaphragm. The diaphragm, unlike other muscles affected reflexly by irritation of structures with which they are associated functionally, becomes immobile in relaxation instead of contraction. Intra-abdominal pressure causes the affected side to rise to an abnormally high level. The more intense the pleurisy, the greater the degree of diaphragmatic paresis, the more prolonged the pleurisy, the greater the probability that the paresis will become paralysis. Immobility of the diaphragm is of great value in the early defense against infection, providing conditions favorable to the maximum blood supply and the most effective degree of the restriction of motion. Permanent paralysis is a handicap contributing materially to exertion dyspnoea.

Prevention of diaphragmatic disability is one of the most urgent demands for the early treatment of spontaneous pleurisy and for the prevention of pleurisy after thoracotomy. It is another indication for drainage.

*Intrapleural Negative Pressure.*—Deviations from normal negative pressure cause interference with respiration and circulation. Slight reductions are evidenced by dyspnoea and palpitation upon exertion. Abolition of negative pressure causes asphyxia because pulmonary inflation ceases. A small collection of fluid suffices to produce effects because variations in pressure are not confined to one part or to one side of the chest, as Graham and Bell<sup>3</sup> have shown. The least harmful abnormality in negative pressure obtains so long as pleural surfaces are opposed. This argues against artificial pneumothorax as a therapeutic measure and is another indication for drainage where effusions are present.

*Pulmonary Elasticity.*—If a portion of a lobe does not inflate normally, it affects the entire lobe by acting like a splint. If the inflation of one lobe is sufficiently impeded, the motion of the entire side of the chest is reduced. The longer a lung is compressed, the more difficult reinflation becomes, and, should atelectasis be combined with compression, reinflation soon becomes impossible. A subjacent cortical pneumonitis is constantly provoked by an acute pleurisy. Its extent and intensity varies with the intensity and duration of the pleurisy. This form of parenchymatous inflammation is almost certain to go on to organization and becomes an additional restriction to inflation. It is relieved ultimately, as pleural adhesions are eliminated, by active motion—respiration.

Again arises the same problem, the limitation of the extent, duration, and intensity of the pleurisy, and the same solution presents itself—drainage.

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Up to this point an outline of the more significant pleural reactions has been attempted to establish principles of treatment which shall work in conjunction with natural processes of defense and repair. Similar reactions in the lung and in the parietes remain to be considered.

Pulmonary defense and repair is more important in protecting the pleura than in safeguarding the lung parenchyma, which is one of the most resistant and smoothest healing tissues in the body. Fortunately, the conditions which give the greatest protection to the pleura have the same influence upon the lung. Repair of tissue in general is fostered not so well by absolute immobilization as by the restriction of motion, which prevents too great traumatism and at the same time assures an adequate blood supply and the continuation of nerve activity. The optimum point of restricted motion for the lung occurs with a reduction in negative pressures which corresponds to that produced by an immobile diaphragm. This assertion is based upon Cloetta's<sup>4</sup> experiments, Middleton's<sup>5</sup> experimental and clinical observations, and upon the natural methods of defense in pneumonia.

Surgical repair of incisions into lung tissue should be designed to assure the immediate resumption of respiration. Adequate haemostasis and aërostasis is easily obtained. Mass suturing is not permissible; layer repair with multiple fine stitches is required. Closure of visceral pleura must be air tight.

It is obvious that after thoracotomy the chest should be closed with the lungs inflated in order to reestablish intrapleural negative pressure. Pulmonary inflation is best accomplished by a method of intratracheal hypertension attainable with nitrous oxide and oxygen pressure analgesia.

Repair of parietal wounds, including surgical incisions, centers in the immediate healing of parietal pleura. The smoothness of this healing so dominates the reduction of dangers of pleurisy that sacrifices must be made to obtain accurate serosa to serosa approximation and without suture tension.

The significance of these simple details in repair was established by clinical and postmortem observations upon wounded soldiers during a service at the Ambulance de l'Ocean at Lapanne and by experimentation in the Laboratory of Surgical Research at the Central Medical Department Laboratory, A. E. F.<sup>6</sup> At this laboratory a group detailed by Doctor Finney devised methods for practical application of the principles involved. These methods were then used in treating the wounded in advanced hospitals. During a period when the wounded were received promptly and in good condition, the immediate mortality rate, which included two weeks after operation, was four per cent. This was the only period open to fair judgment because delays in transportation at other times made the average duration from injury to operation about twenty-four hours and increased the mortality rate ten times. These experiences together with observations made since the war upon late results obtained

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in the wounded and in civil practice indicate possibilities of progress along certain lines of treatment.

Early drainage in acute pleurisy and primary drainage at the time of thoracotomy have been discredited because of faulty methods employed and not because drainage under these conditions is contraindicated by its antagonism to physiological processes. Willems and Delrez showed that joint drainage by simple arthrostomy and early active motion to furnish the expulsive force and to eliminate adhesions gave recovery with splendid function. Simple air-tight one-way drainage of the chest employing the increased intrathoracic pressure of inspiration and of coughing as expulsive and disrupting forces is similarly effective. Suction should not be used. The proper intercostal insertion of a catheter by means of a trocar and cannula is hardly more serious than a thoracocentesis and provides constant drainage with minimum irritation. Bowditch first showed what early and repeated aspiration could accomplish in the treatment of pleurisy.

A catheter drain armed with a one-way flap valve, inserted when pleurisy is incipient, is only a continuation of Bowditch teaching. This modification will be accepted when two facts are recognized. The first is that an early diagnosis of sero-fibrinous pleurisy can be made and fluoroscopically confirmed before it is possible to aspirate fluid with certainty without the aid of a fluoroscope. This stage corresponds to early acute appendicitis. The second is that empyema which is a late stage of sero-fibrinous pleurisy is as flattering commentary upon clinical methods as purulent peritonitis arising from appendicitis. Both are confessions of therapeutic failure. Even after empyema has developed, catheter drainage should be tried first, with or without lavage with Dakin's solution as conditions demand. This simple treatment may obviate open operation and will usually reduce its magnitude if it becomes indicated later.

Primary drainage after laparotomy was found to be harmful because the general peritoneal cavity cannot be drained and because all forms of drains increased instead of reducing intraperitoneal irritation. Primary drainage after thoracotomy has been discredited because it did not preserve intrapleural negative pressure and therefore assured pulmonary collapse. Drainage of the pleural cavity is easy and pleural irritation slight if the tube is introduced so as to avoid undue contact with the visceral pleura. Thoracotomy is invariably followed by serous effusion which is so extensive as to be easily demonstrable on the second or third day. Its dangers are so definite that many of the best surgeons follow Bowditch's teaching by having their patients aspirated as a routine at this time. The aspirations are repeated at intervals until fluid disappears.

All intrathoracic surgical operations can be performed under nitrous oxide and oxygen analgesia and the degree of inflation or deflation of the lung can be suited to the operative requirements. This method, de-

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veloped by Doctor J. T. Gwathmey's following up a lead given by Doctor Crile, is superior in doing away with deeper narcosis required to introduce intratracheal or intrapharangeal tubes and utilizes the cylinder pressure of the gases instead of any more or less elaborate apparatus to provide differential pressure. Above all it is safe if used with reasonable care.

The significance of diaphragmatic relaxation in protecting the repair in lung and pleura is not appreciated. It is a natural method of defense and should be induced therapeutically. For instance, if the phrenic nerve be blocked by injecting one per cent. cocaine in the early steps of a thoracotomy, the operation is facilitated by reduced motion and the recovery after operation is more certain, more rapid, and less distressing. This paralysis lasts four to five days and then gradually disappears. The pain incidental to pleurisy caused by malignant growths can be materially reduced by dividing the phrenic in the neck or injecting it with alcohol. Possibly the most important indication for inducing diaphragmatic palsy is in the treatment of pulmonary tuberculosis of the type now combated with artificial pneumothorax and for reasons stated above. Individuals with diffuse pleural adhesions which make artificial pneumothorax impossible could be given the same advantage. The injection of alcohol into the cervical trunk of the phrenic in concentrations suitable to the desired duration of paralysis can be done easily under local anaesthesia. Dogs are little embarrassed if both phrenic nerves are blocked, so possibly the diaphragm may be paralyzed on both sides in the tuberculous with advancing bilateral lesions. There is no evidence that a paralyzed diaphragm seriously interferes with the raising and expectoration of morbid bronchial secretions.

These principles applied to surgical methods make thoracotomy a safe operation because they afford a control of pleurisy and protect respiration and circulation. It were folly to attempt to predict the attainments of intrathoracic surgery in the immediate future, so great are its possibilities.

The same principles applied by internists will reduce the incidence of empyema, relieve much of the distress of tuberculous pleurisy, and probably improve the results obtained in treating pulmonary tuberculosis.

An increasing recognition of the frequency of impaired diaphragmatic function resulting from slight attacks of pleurisy indicates the greater attention which must be given to the prevention of late complications by early active motion of the lungs as soon as curtailment of the acute process permits. The importance of deep and free respiration becomes more and more evident. Preventive and therapeutic measures to obtain desired results are determined by thoracic physiology. Much remains to be learned, and there is scarcely a laboratory or clinical worker who can avoid finding some suggestion for renewed activity if the problem is considered broadly.

The demand for manpower during the war caused the development

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of methods of treatment which would return the wounded to duty in the least time and competent for indefinite service. The demands of peace times are the same, though the recognition is less general. There is not one law of tissue repair for war and another for peace. Function will always depend upon tissue integrity. If the knowledge of repair gained by war medicine is applied to civil practice, and with the same end in view, the death, distress, and disability prevented will soon exceed that caused by the conflict.

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- <sup>2</sup> Delrez: Arch. Méd. Belges, 1919, lxxii, 513 and 602.
- <sup>3</sup> Graham and Bell: Am. Jour. Med. Science, 1918, clvi, 839.
- <sup>4</sup> Cloetta: Arch. of Clin. Chir., 1912, xcvi, 835.
- <sup>5</sup> Laboratory of Surg. Research, A. E. F., Boston M. and S. Jour., 1919, clxxx, 403.

## WAR WOUNDS OF THE CHEST\*

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THIS paper is based upon fifty-one operative cases of wounds of the thorax involving the chest wall, the lungs, and thoracic contents, or associated with injuries to the diaphragm or abdominal viscera. It is limited to the immediate operative results obtained in a hospital working in close proximity to the battle line and is not concerned with the treatment or mortality of such cases in the hospitals on line of communication or at the Base. The surgical material represented about 3.6 per cent. of our entire operative experience. In certain sectors the percentage of wounds of the thorax to other wounds varied, depending upon whether the surgical team operated in a field ambulance, a mobile hospital, or an evacuation hospital. The proportion of chest cases received was directly proportional to the proximity of the hospital to the front line and correspondingly the greater the percentage of mortality.

In our experience the surgery of the chest embraced three distinct phases. The first period was a policy of non-intervention and at the height of a push or an offensive the attitude of "laisser faire" was employed. There were a number of reasons for this inactivity. In the first place, the wounded ordinarily did not arrive at the hospital until some time after their injury and had passed the golden time for operative treatment, namely, four to eight hours after receiving the injury. In our own personal cases the average time of arrival of wounded chest cases was 19.7 hours, while the earliest time was four hours, and the longest ninety-six hours. At the height of an offensive a complete chest operation with special surgical team and equipment required so much time and organization that few hospitals could provide the same or allow to be deflected so much professional talent for such work. From an army standpoint the time and ability of a surgical team could be more profitably employed on other and less grave injuries, so that from a distinctly military point of view it was wiser to adopt an attitude of non-intervention during the stress of a big offensive.

The second period began with the Marne Campaign of 1918 when the American service had adopted an attitude midway between non-intervention and so-called radical surgery. The surgical teams exercised wide latitude in interpreting the varying signs calling for operative intervention. It was not long, however, before a surgeon appreciated the essential fact that open or sucking wounds of the thorax should be closed for mechani-

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cal reasons alone, irrespective of the infection likely to ensue. The first operations that most of the surgical teams were able to do were rather varied with a distinct tendency toward conservation. At this time the technic consisted in débridement of the external wound, the wiping away of superficial blood, the excision of necrotic, infiltrated or contused muscle tissue, the removal of splinters of bone, and the closure of the pleural wound by the interposition of muscle covered with skin.

In these earlier operations no attempt was made to repair or to débride the traject in the lung tissue or to remove the foreign body by a well-planned technic. It was soon apparent, however, that a small percentage of these cases died of shock or hemorrhage while the majority died of infection. Every case so treated was a potential empyema or pleuro-pulmonary infection.

The third period embraced a period of active or radical surgery in that practically all cases, except those with small foreign bodies or perforating chest cases with small orifice of entrance or exit and such few cases as were doing comparatively well with closed wounds and slight dyspnea, were submitted to operation.

An analysis of the postmortem findings in a series of cases dying as a result of wounds of the chest reveals that in those dying within the first forty-eight hours the cause of death was anatomical, namely, shock; mediastinal flutter, combined injuries to diaphragm and abdomen, or multiple wounds. In those cases dying after forty-eight hours the cause of death was due to sepsis. Ninety-six per cent. of deaths in injuries of the chest are due to sepsis (Henry and Elliott). This septic death-rate of 96 per cent. is remarkable when contrasted with the normal or average septic death-rate of 26 per cent. in an active mobile hospital. Occasionally the septic death-rate may reach 33 to 35 per cent. The bacteria involved in the high septic death-rate of chest cases are: Gas-producing organisms, 48 per cent.; streptococci, 40 per cent.; and lung organisms, 12 per cent. In 500 cases of hemothorax the routine specimens aspirated from the chest demonstrated that 195 cases were infected and of these 87 were infected with anaerobes.

Except for the deaths occurring within a few hours after the injury from shock and loss of blood, the fatal issue of modern chest wounds was almost always due to sepsis in one form or another.

The one outstanding problem before surgeons in this war in wounds of the thorax was the prevention and checking of infection which is carried into the wound in the large proportion of cases.

All wounds of the chest are potentially infected. Modern surgery, however, was able to obviate, inhibit or prevent infection if the surgeon was able to operate during the golden period of operability—the first eight hours, preferably four, between the receipt of injury representing contamination, and the development of infection which ordinarily became apparent about the eighth hour.

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The ideal operation contemplated: (1) Débridement of all soft tissue about the orifice of entry or exit, particularly all portions of contused, necrotic, or infiltrated tissue in or about the area of the wound; (2) the regularization of all bone ends; (3) complete esquilectomy or the removal of all bone fragments, particularly the in-driven spicules of bone in the lung or pleural cavity; (4) the removal of the foreign body, unless smaller than the nail of the little finger; (5) a débridement of the traject in the lungs and if badly infiltrated or lacerated resection—partial or complete lobectomy; (6) adequate surgical and anatomical repair of the lung by suture; (7) complete toilette of the pleural cavity, removal of blood, foreign bodies, fragments of bone, portions of clothing, etc., many times lying free within the costo-phrenic sinus or impinging upon the opposite chest wall; (8) the repair of the diaphragm and such intra-abdominal exploration as would seem indicated; (9) the hermetical closure of the wound in the chest wall by any of the accepted methods.

*Classification of Wounds of the Thorax.*—A satisfactory classification of war wounds of the thorax could be arranged as follows:

1. Perforating wounds, through-and-through, due to bullet.
2. Perforating wounds, through-and-through, due to shell fragment.
3. Penetrating wounds, with retention of large foreign body.
4. Penetrating wounds, with retention of small foreign body.
5. Tangential wounds.
6. Cave-in, stove-in, or crushed-in chest.
7. Sucking wound or open thorax.
8. Combined abdominal or multiple wounds.

In my own experience there were operatively proved injury to the chest, 51 cases; gunshot wounds, 40, with 15 deaths; bullet, 4, with 1 death; undetermined, 7, with 2 deaths. The types of injury were perforating, 23; penetrating, 17; tangential, 2; cave-in, 2; thoraco-abdominal, 7.

Total mortality, 18.

Mortality by type of injury—tangential wounds, 2, no deaths; perforating wounds, 23, 6 deaths; penetrating wounds, 17, 6 deaths; cave-in, 2, 1 death; thoraco-abdominal wounds, 7, 5 deaths; admitted in pronounced shock, 19, with 8 deaths; admitted with sucking wounds, 15, with 11 deaths; hæmorthorax, 28, with 12 deaths; hæmopneumothorax, 5, with 2 deaths; the ribs were fractured in 18, with 8 deaths; the scapula 6 times, with 4 deaths.

The average duration between injury and arrival at hospital was nineteen hours; the earliest time four hours, and the longest time ninety-six hours.

The immediate mechanical and anatomical effect of a war wound of the chest is a sudden blow to the chest wall with penetration and in about a third of the cases with fracture of a rib. The projectile courses on through the lung or drives bone fragments before it, the bone fragments constituting secondary projectiles and adding considerably to the laceration of the lung tissue. These fragments or spicules of bone are

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very frequently dispersed over a considerable distance around the traject of the missile and increase the hemorrhage and aggravate the subsequent infiltration and contusion. In many cases the missile passes out through to the opposite wall, and if it succeeds in making its exit does so with eversion or bursting out of the wound of exit. I have never found a bullet imbedded in lung tissue but have found it arrested by the ribs or soft tissue of the opposite chest wall or lying free in the pleural cavity. Very soon the immediate portion of the injured lung about the traject collapses and is submerged in blood or floating free about the hæmorthorax, while the upper portion may show emphysema with skodiac phenomena. The most dangerous element in the mechanism of this injury is due to the secondary injury from bone fragments which are often projected at considerable distances from the wound and the infectious material carried far into the tissue by the foreign body.

*Surgical Indications.*—A summary of the surgical indications for operative intervention could be tabulated as follows:

1. The closure of sucking wounds of the chest wall irrespective as to the retained foreign body or the mechanism of production of the injury.
2. Continued bleeding or unusual hemorrhage.
3. Grossly infected, contused or contaminated wounds of the soft tissues. This variety eliminated the cases with a clean-cut rifle bullet wound or the penetrating type of wound due to small shell fragment.
4. Wounds with fracture of the ribs, clavicle, scapula or vertebra, complicating the original or primary injury.
5. The retention of foreign bodies other than small eclat. By small we mean a shell fragment certainly not larger than the nail of the little finger.
6. The onset of a progressive hæmopneumothorax.
7. Stove-in or crushed-in chest with multiple fractures of many ribs whereby the bone ends protrude into the pleural cavity, bringing about a laceration of the lungs.

*Clinical Aspects.*—Turning now to the clinical phase it is quite obvious that war injuries to the thorax comprise those that die immediately on the field, those who are able to be brought to a regimental aid post, and those capable of sustaining a trip to a forward operation formation. Those that are evacuated from a regimental aid post comprise approximately 4 per cent. of the battle casualties received in the forward operating theatre.

In one week in the Marne in the latter part of July we received six chest cases out of sixty wounded. In the Marne the first week in August twelve out of fifty-two cases, while in September at the St. Mihiel sector thirteen out of ninety-four operative cases, the relative frequency of chest cases depending entirely upon the proximity to the battle line.

According to Bissell, 90 per cent. of the deaths from wounds of the thorax that occur on the battlefield are due to shell fragments that have

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penetrated or entered the thorax over an area corresponding roughly to two closed fists front and behind. It is rare for injuries to the heart and large vessels to reach an operating theatre by reason of the rapid onset of death.

I have operated upon three cases of injuries to the pericardium and one to the heart in an operative experience of about 1600 cases, but have never had a personal case of bayonet wound of the chest. Presumably they all died on the battlefield.

The consensus of opinion among the surgical teams of the American service was that 50 per cent. mortality at the field ambulance or mobile hospital was a normal battle casualty mortality for gunshot wounds involving the chest, lungs, pleura or diaphragm.

Hæmoptyisis occurred as initial symptom in 25 per cent. of cases and was present in about 75 per cent. of all histories, sometimes occurring on the second or third day. In perforating wounds of the chest it soon lost its bright bloody character and became streaky. (Six per cent. of thoracic wounds were complicated by injury to the vertebral column and spinal cord.)

Hæemothorax occurred in three types: (1) Massive (1500-2500 c.c.) with collapse of the lung, the blood reaching sometimes to the level of the clavicle; (2) moderate (1000-1500 c.c.) with the lung floating on top and compressed and retracted against the chest wall; (3) minor degrees (500 c.c. or less). When the amount of effusion in the hæemothorax reaches about two litres there is an entire collapse of the lung which tends to retract and rest against the vertebral column and is usually free from any adhesions.

Hæmopneumothorax may be classified as exogenous, when it occurs from an open wound in the chest wall, representing the so-called sucking wound, and endogenous when produced through direct injury to the lung tissue. The development of free gas from the growth of anaërobies within the pleural sac is a more common cause in this condition—pneumothorax—than is leakage of air into the pleural cavity. Odor to the fluid from the pleural cavity is one of the most certain indices as to infection—a foul odor as the result of infection with anaërobies together with a buff-colored deposit showing the addition of pus cells to the blood fluid.

The complication of fracture of the ribs with an injury to the lung is one of the most dangerous types of war wounds of the thorax, for in addition to the projectile there are numerous bone splinters driven into the lung. This is particularly noticeable in injuries involving the flat surface of the scapula. In a case at Evacuation Hospital No. 4, at Congy, innumerable bone splinters were found within the lung at varying depths up to 11 cm., and a few closely attached to the projectile itself. The removal of these bone fragments or esquilles is one of the cardinal principles of technic.

In the first twenty-four hours movement of the mediastinum to and

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fro is particularly dangerous by reason of the shock produced. At the end of twenty-four to forty-eight hours there is an exudation and infiltration with fixation of the mediastinal pleura. This renders the opening of the chest after forty-eight hours a matter of much less danger than opening a freshly wounded chest.

In open wounds of the chest there is no fluid to splint the lung as in the closed cases, and there is distinct disadvantage in waiting. Under plugging and rest, or as an emergency procedure, the drawing of skin together with silkworm sutures at the regimental aid post, mediastinal flutter is prevented and these patients recover from most of their symptoms.

Traction with a Collin lung forceps upon the injured lung will tend to diminish mediastinal movement, as will placing the patient in a recumbent position with the shoulders elevated and the injured side most dependent. The lung being grasped, it requires very little traction to stop mediastinal movement and the lung may be held in place with a transfixion suture. In the early days of the war—1916-1917—the lung was sutured to the parietal pleura. This we believe to be a faulty practice, for in the condition of partial collapse of the lung or upon traction of the lung to the parietal pleura it is impossible to obtain a normal anatomical relocation of the lung to the chest wall as it existed under natural conditions. The withdrawal of lung into the opening of the wound as recommended by Lilienthal and transfixing it with a pin has not been performed by me but would seem to suggest itself as a very good procedure.

All of the surgery performed was done without the aid of any apparatus or special equipment. In only a few of the cases were we able to obtain nitrous oxide or oxygen anaesthesia. The expansion of the lung by nitrous oxide or oxygen is particularly valuable during the placing of the last pleural closure sutures. The escape of nitrous oxide or oxygen gas into an air-tight mask will forcibly expand the lung until it occupies the entire pleural cavity. When this is accomplished the pleura is hermetically sealed by suture.

*Fatalities.*—In reviewing the causes of death from war wounds of the chest it was found that fatalities occurred in four groups: (1) The unoperated dead—the cases where death occurred a few hours after admission and being due to multiple injuries, hemorrhage or shock. Many of these cases left the regimental aid post alive, but arrived at the hospital dead in the ambulance. (2) The immediate operated dead—the cases that died upon the operating table or immediately thereafter. There is a condition of the wounded soldier which is lethal and beyond which he can sustain no further loss of blood and certainly no surgical procedure, and if operation is attempted in this type all methods of resuscitation fail to save him, whereas blood transfusion before operation will prepare him for an ordinary operative undertaking. (3) The later operative dead, where death occurs at the end of the second or third day of sepsis. (4) The unoperated cases which died as the result of infective haemo-

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thorax—five or six days later—and who occasionally had a late thoracotomy performed as an emergency or drainage operation.

*Technical Procedures—Choice of Route.*—The operative approach varied with the type of injury and its location. Where adequate exposure could be obtained through either the orifice of entry or exit intrapleural procedures were carried out through this wound. If the wound was in a suitable position four to six inches of rib were removed subperiosteally, the rib space spread by means of a rib spreader, the pleural cavity carefully cleansed of all blood, the hand inserted and the immediate subadjacent lung delivered into the wound. In every case the attempt was made to remove the foreign body unless it were smaller than the nail of the little finger. In every case the laceration and traject in the lung was cleansed and closed. The mechanical cleansing of the traject was oftentimes incomplete, but it was early established that the lung tissue itself, by reason of its peculiar vascularity, was quite able to take care of a considerable degree of infection. As evidence pointing to this contention one recalls the extreme rarity of gas gangrene of the lung tissue itself. The handling of the lung was not associated with marked fall in blood pressure and was not associated with the same degree of shock as would be induced by similar manipulations of the intestines.

In wounds in the scapular region perforating high up between the vertebral column and the scapula it was rather difficult to obtain adequate access to the pleural cavity. Trephining the scapula proved a very unsatisfactory procedure and excision a needless loss of bone substance. It was much better to divide the rhomboid muscles, the serratus magnus and the latissimus dorsi at the lower angle of the scapula and throw the scapula upwards and outwards. If the nature of the wound would permit resection of the fourth or fifth rib was carried out from the midscapular line upwards to the posterior axillary line. This approach permitted free entry into the chest and allowed the hand to be inserted and the lung delivered. It was better not to advance the anterior incision to the costal cartilage, as the cut end of the cartilage made it difficult to close the pleural cavity at this point. If the wound involved the chest wall at the bottom of the axillary space it almost uniformly perforated the diaphragm and injured the abdominal viscera. It was surprising to note how many times there were wounds of the abdominal viscera without any injury to the lung. On the right side we encountered gross injuries to the liver and kidney, and on the left laceration and injury to the spleen and stomach. In this type of injury an intercostal thoracotomy was done from the midscapular line to the anterior axillary line in the eighth intercostal space; through this aperture it was comparatively easy to repair wounds of the diaphragm and to carry out quite extensive work on the abdominal viscera when necessary. Through this incision the lower portion of the lung can be delivered and partial lobectomy performed if necessary. Total lobectomy has never been necessary in our

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hands, but partial lobectomy was done four times. The incised surface of the lung was approximated with a lock-stitch for hemorrhage. We have never had trouble with open bronchus and have never given particular attention to the same, so far as we could judge, it being sufficient to have a lock-stitch for hemorrhage with possibly an approximation suture for the visceral pleura.

Where an injury was low down with compound comminuted fracture of the sixth, seventh, or eighth rib in the midaxillary region, then the incision was enlarged by resecting the seventh rib. Through such an incision the pericardium was sutured twice and in another case a large transdiaphragmatic hernia was replaced with ease. When the diaphragm was injured well out in the costo-phrenic sinus the central portion was occasionally sutured to the parietal pleura. This technic was only employed in combined thoraco-abdominal cases, and where it was essential to close the pleural cavity and at the same time insert gauze into the renal fossa or into the liver. Rarely a loss of substance of the diaphragm could more easily be repaired by suturing the lacerated edge to the parietal pleura than by closure of the defect.

In about one-third of the cases it was possible to get sufficient lung tissue through either the orifice of entry or exit to remove the foreign body and to repair the damaged lung. It was not infrequent to find that the foreign body after having traversed one of the chest walls and a lobe of the lung would be arrested by the opposite chest wall and drop free into the costo-phrenic sinus. In the case of shell fragment the velocity not being very great the fragments ricochet from the far wall of the chest and drop down into the costo-phrenic sinus.

*Hæmorthorax.*—The question as to what should be the surgical procedure in the cases of simple hæmorthorax due to gunshot wounds was among the most difficult that we were called upon to decide. Aspiration of the contents of a simple hæmorthorax did not always show bacteria, but many cases went on and developed fulminating sepsis.

It was found that aspirations taken at different levels gave different bacterial findings. It was considered that about 65 per cent. of all injuries to the chest if left alone or simply had the external wound débrided would develop an empyema. Whether these cases were to be operated upon or left alone was a matter largely of individual judgment. Some of the factors which influenced the surgeon were as follows: (1) A hæmorthorax due to bullet: the wounds of entrance and exit are small and clean and the damage consisted of a moderate hæmorthorax of about 500 c.c. of blood. Of this type about 25 per cent. will become infected and of the infected cases 50 per cent. will die, and the remaining 50 per cent. will have a long period of pleural suppuration and a third of them will be permanently disabled.

As an example of another type of wound a little bit more severe is a case of a soldier with a through-and-through wound from a shell fragment

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with mildly infected wound of entrance and exit and a moderate haemothorax of about 500 c.c.; 50 per cent. of such cases will become infected and half of these will die under ordinary circumstances, and the remaining half infected will have a prolonged period of suppuration and a third of them are permanently disabled.

I was personally unable to formulate any definite indications for surgical intervention in these restricted types of chest injuries. The condition of the patient, the interval since injury, the absence of marked pain (pain out of proportion to the observed wound usually indicated in-driven bone fragments), the absence of continued haemoptysis or cough, and the absence of dyspnoea and cyanosis were sufficient reasons for treating the cases expectantly and, unfortunately, all too frequently to be regretted.

The cases of infective haemothorax were profoundly influenced for the better by the introduction of Tuffier tubes and the instillation of Carrel-Dakin solution. A large rubber exit tube was placed in a most dependent portion of the pleural cavity and a number of 4, 5, or 6 Carrel-Dakin tubes inserted into various parts of the pleural cavity. Through these tubes an ounce to two ounces of Carrel-Dakin solution was introduced every two to four hours; the excess of fluid being drained off through the large exit tube. The interstices between the Carrel tubes were lightly packed with gauze. This was our procedure in cases that had not been primarily operated upon when brought into the hospital but who later needed a thoracotomy for infection.

A rather interesting observation was made that after the Carrel-Dakin fluid had been employed for four or five days the discharge was considerably blood stained; upon stopping the instillation of Carrel-Dakin for forty-eight hours this usually cleared up.

The post-operative treatment consisted in placing the patient in a sitting position with the injured lung somewhat dependent. Dyspnoea, cough, and pain were controlled with morphine (gr.  $\frac{1}{4}$  to gr.  $\frac{1}{2}$ ) every four hours until the patient was distinctly narcotized. These cases had an extremely stormy time for two or three days after operation, the temperature was markedly elevated ( $102^{\circ}$ - $104^{\circ}$ ) with considerable frequency of pulse and in many cases marked dyspnoea.

The operative deaths that resulted usually occurred shortly after operation, and if the patient survived the first twenty-four hours it was a reasonable expectation that he would pull through to such a condition of well-being as to render evacuation to the rear safe.

## GUNSHOT WOUNDS OF THE CHEST

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At the beginning of the war, the expectant principle of treating chest wounds was followed for small through-and-through punctured wounds produced by rifle or machine-gun bullets. This did very well, but a more active plan was essential for the so-called "stove-in chest" with retained foreign bodies, wounds, for the most part, produced by high explosive shell fragments. Active treatment of chest wounds was started by the English and French surgeons in 1916, following the battle of the Somme, and consisted in the excision of the wound, complete cleansing of the pleural cavity, removal of the foreign body, when possible, and primary suture. From the similarity of lung and pleura wounds to other wounds of war, it will readily be seen that the same surgical treatment should apply.

In a series of gunshot wounds classified according to the anatomical region involved, our records show that wounds of the thorax (139) constituted 8.6 per cent. Of these 118 involved the chest wall. Twenty-one were intrathoracic wounds. There were no wounds of the heart seen. Penetrating wounds of the lung and pleura (21) composed 17 per cent. of our gunshot wounds of the chest.

The cases that reached this hospital had already received treatment, and the work here consisted principally in having all chest cases X-rayed and in watching them carefully for complications. As soon as a case came into the hospital, cultures were taken from the surface of the wound and from the wound cavity. The subsequent treatment depended upon the clinical and laboratory reports. The X-rays taken at the front did not always coincide with those obtained at the base. Fluid from the pleural cavity was subjected to microscopic and bacteriologic examination. At times the only guide to infection was the temperature and pulse.

There was a certain number of cases showing severe injuries to the chest wall, and this type required careful X-ray examination to determine the presence of foreign bodies.

In these cases in which there had been penetration of the lung substance with retention of the foreign body, an interesting series of cases developed. These cases bring up the question of what final disposition is made of the retained foreign body in the lung. The general opinion seems to be that a retained foreign body wherever situated will sooner or later give rise to trouble. It is possible for a foreign body in the lung

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to become encapsulated, it may be a nidus of infection or it may eventually project itself into the pleural cavity. There are cases reported in which the foreign body was coughed up with a spontaneous cure. Early removal is the best plan, however, when possible. If not removed early and an empyema develops, it cannot then be removed with safety, unless easily accessible, until a later period.

A case illustrating this is shown in a German prisoner of war received at this hospital on October 15, 1918. He was wounded October 9, at 8 A.M., and was dressed after his capture on the field two hours later. He was removed in an ambulance, but the car was wrecked by shell fire and the patient crawled into a dugout. He received no attention for three days, and was without food for this time. He was admitted to this hospital on the 15th, and as we had no X-ray equipment at the time no picture was taken. The operation consisted in the removal of the broken ribs and bone fragments with the evacuation of large quantities of pus from the pleural cavity. Rubber-tube drainage was inserted. Cultures of the fluid showed staphylococcus, Gram-positive and Gram-negative cocci. Later an X-ray of his chest was obtained which showed a foreign body  $2\frac{1}{2}$  by 1 cm. Following the operation the patient continued to improve with a gain in weight. The empyema ran the usual course and he was later discharged from the hospital. No attempts were made to remove the foreign body. The above case shows the extraordinary resistance the lung has to a foreign body.

Another instance of retained foreign body in the lung was seen in the case of Sergeant C. W. of the 326th Infantry, aged twenty-two years, who received multiple gunshot wounds of the right forearm, thigh, and top of shoulder. It was through the latter that the missile penetrated the chest. This patient was wounded October 14, 1918, in the Argonne, at 8 P.M. At 8.30 he jumped on a moving ambulance and was taken to Field Hospital 328. He remained two hours and was taken to Evacuation Hospital 11. October 15 an operation was performed on the arm and thigh under local anaesthesia. A foreign body was removed from the thigh. X-ray demonstrated a foreign body in the chest. The patient coughed up blood.

He was admitted to Base Hospital 61 October 16, 1918. The X-ray showed a foreign body which moved with respiration in upper right chest. The foreign body had entered the chest through the wound on the top of the right shoulder between the outer end of the right clavicle and the spine of the scapula. He showed the physical signs of a thickened pleura, from the fifth space to the base anteriorly, and the angle of the scapula to the base posteriorly.

This patient also had a partial paralysis of the ulnar and radial nerves, but showed improvement. The wounds healed.

Upon discharge physical examination of the chest was negative. Total expansion was  $2\frac{1}{2}$  inches, right side 1 inch, and left side  $1\frac{1}{2}$  inches. Heart action at rest was 86, after exercise, 120. Absence of complications in this case is noteworthy.

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There are two definite groups of late symptoms in cases of retained foreign bodies of which these cases complain; those having a physical basis and those in which the symptoms are largely nervous. In that class showing nervous symptoms the presence of the foreign body appears at times to cause a certain amount of mental anxiety. The question of operation in these cases for the removal of a foreign body is a difficult one to settle. We must remember that these cases have recovered from a severe injury, and that a thoracic operation can not be considered lightly. In certain selected cases in which the symptoms are very pronounced, and localization shows that the foreign body is easily accessible, a secondary operation is justifiable.

There is a group of haemothorax cases, for the most part through-and-through wounds, which entered the hospital. These cases were carefully screened and rayed and if infected were drained. The following will illustrate a case in which aspiration sufficed to effect a cure.

M. B., private, Co. R, 165th Infantry, received a through-and-through bullet wound of the right chest. He was wounded in the Argonne on October 13, 1918. He was in the field for an hour and crawled behind a bank at the roadside. He remained there for several hours and then walked three kilometres until picked up by an ambulance. He was driven about six kilometres to a field hospital where he received an injection of anti-tetanic serum. Several hours later he was removed to Evacuation Hospital 16, where he arrived at 2 A.M., October 14. Here he was fluoroscoped and no fluid or foreign body demonstrated. En route to the evacuation hospital he coughed up blood. On October 16 he arrived at Base Hospital 61, and examination revealed a healed wound of entrance in the mid-clavicular line  $1\frac{1}{2}$  inches above and somewhat internal to the nipple. A wound of exit was found  $2\frac{1}{2}$  inches to the outer side and below the angle of the right scapula. Vocal fremitus was decreased posteriorly on the right side and there was dullness over the same area. Breath and voice sounds were decreased below the angle of the scapula behind. Total expansion was  $1\frac{1}{2}$  inches, right  $\frac{1}{2}$  inch and left 1 inch. An X-ray picture indicated fluid to the level of the third rib in the axillary line. On aspiration 900 c.c. of bloody fluid was obtained. Culture of this fluid showed Gram-positive diplococci. Another picture, taken November 29, still showed a small amount of fluid at the base of the right chest. On November 3 and 4 the temperature reached  $101.4^{\circ}$ . At all other times it had been normal. This soldier was later returned to the United States.

As is to be expected, pneumonia and empyema are frequent occurrences. The latter may be the usual post-pneumonic type, or the mode of origin may be directly traced to the infection by the foreign body. It must not be forgotten that an otherwise uninfected haemothorax may be easily converted into an empyema, either from insertion of a dirty aspirating needle into the chest, or if the needle punctures the lung in an infected

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area the chest fluid may become infected upon the withdrawal of the needle. Pathogenesis in these cases may be impossible to determine. This is true of the following case:

Private, Co. D, 167th Infantry, aged twenty-four years. Diagnosis: Perforating wound of the right chest. Fracture of the superior angle of the scapula, fracture of the fourth, fifth, sixth, seventh, eighth, and ninth ribs. The patient was wounded on October 14, 1918, and passed through Evacuation Hospital 11 two days later. The wound of entrance was in the right shoulder. He suffered from shock and haemoptysis. The right chest was aspirated and a pint and a half of bloody fluid removed. Three days later a quart was withdrawn. On October 22 he was admitted to Base Hospital 61. On admission he complained of dyspnoea and thoracic pain. His temperature was 103°. An exploratory puncture was at once made and no fluid was obtained. Examination of the chest showed definite signs of bronchopneumonia. On October 24 an X-ray showed the right chest markedly opaque. A machine-gun bullet was located in the left side of the chest, on the level with the first lumbar vertebra and a small foreign body in the right chest. The following day 20 c.c. of sanguinous pus was removed. The aspirations were continued daily until November 1, when a portion of the ninth rib was excised under local anaesthesia and drainage secured with two rubber tubes. A week later special Carrel tubes were placed in the wounds and the right chest was irrigated with Dakin's solution. Smears taken showed Gram-negative diplococci, staphylococci, and streptococci. Under this treatment his general condition improved with a fall in temperature. The patient did not take the irrigations well and they were subsequently discontinued. This was probably due to a communication with a bronchus, as he coughed considerably, which was thought to be due to the chlorine vapor. On December 9 an X-ray plate showed the foreign bodies and an abscess cavity on the right side surrounding the small foreign body. During this time the patient was in such poor condition that it was doubtful whether he would recover. Physical examination showed a machine-gun bullet under the skin on the left side, between the eleventh and twelfth ribs, about 5½ inches from the spine. The patient ran the usual course of an empyema, the machine-gun bullet was removed, the operative wound closed, and the patient subsequently evacuated to the United States.

Small localized empyemas are very likely to be overlooked. Repeated X-ray and physical examinations are necessary to detect them. Sinuses are sometimes misleading, as they are not always connected with a demonstrable foreign body, being at times due to imperfect obliteration of a cavity.

A case of mixed infection, bilateral broncho-pneumonia, following a penetrating gunshot wound of the right chest with subsequent empyema, was seen in the case of Private V. A., Co. G, 166th Infantry, aged twenty-three years. He was wounded October 14, 1918,

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and admitted to Evacuation Hospital 10 two and a half hours later. On fluoroscopic examination a foreign body (character not mentioned) was located between the ribs. The chest cavity was not entered. Débridement and removal of the foreign body  $\frac{1}{4}$  cm. long (probably shell fragment) was done. He was admitted to Base hospital 61 October 16, 1918. There was a wound on the right chest between the seventh and eighth ribs anterior to the axillary line. A bilateral broncho-pneumonia developed. The sputum showed Type 2 Pneumococcus. The heart was pushed to the left. Definite signs of fluid. On November 2, 1800 c.c. of cloudy fluid was withdrawn from the right chest. This, upon examination, showed Gram-positive streptococcus and diplococcus.

On November 4, 300 c.c. of fluid was again aspirated from the right chest. On November 16 excision of one inch of the eighth rib in the right posterior axillary line was made, and the chest drained. The temperature was subsequently within normal limits. Upon discharge expansion of the right lung was good. Percussion note was somewhat impaired in the lower chest. This patient was sent to the United States.

Pneumothorax of varying degrees is seen as such, but more frequently associated with haemo- or pyo-thorax. A marked degree of subcutaneous emphysema is rare, but may result, as was noted in the following soldier:

Sergeant W. M. C., 61st Infantry, M. G. Co., was admitted to our hospital November 14. He had a penetrating wound of the chest produced by a machine-gun bullet. This patient was wounded November 6, and passed through Field Hospital 25 and Mobile Hospital 8. There a machine-gun bullet was located in the muscles of the back and removed. Débridement of the anterior and posterior wounds, with primary closure of both pleura and skin, was done. The day following he developed an extensive subcutaneous emphysema from head to lower abdomen. On November 14, the date of admission to this hospital, he showed, upon examination, two sutured wounds in the chest. One was on the right side below the clavicle and the other at the lower angle of the scapula posteriorly. The sutures were removed and a large amount of pus removed from the posterior wound and a small amount from the anterior. There was a subcutaneous emphysema of chest and abdomen. The scrotum was distended with air to the size of a foetal head. Radiographic findings showed a fracture of the second rib with evidence of thickened pleura. The patient's condition gradually improved so that on December 2 he had only a slight cough and the wounds were healing with slight discharge. On December 8 his sputum was tinged with blood and he complained of pains in the upper right chest. Physical examination showed an area of cavernous breathing in the right mammary region near the sternum, but three days later this had disappeared, leaving a few râles at the bases. At no time did the temperature rise above  $100.8^{\circ}$ . The average temperature was  $99.4^{\circ}$ . On

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December 16 the breathing and expansion of the right chest was good with slight increased sounds over the lower chest. The patient was transferred to the United States a few days later, perfectly well.

In the series of penetrating gunshot wounds of the lung and pleura there were five deaths. The mortality was about 23 per cent. The autopsy protocols of these cases are appended.

The preceding record presents two main points for discussion, (1) the treatment of retained intrathoracic foreign bodies, (2) hemothorax. In general the proper procedure to apply in the first is governed by the principles which apply to foreign bodies retained elsewhere in the body, *i.e.*, if they are the cause of symptoms they should be removed.

As regards the treatment of the second condition, if infected, these cases should be opened and drained as in empyema.

Combier and Hertz practiced extraction of missiles only in cases that seemed likely to be poorly tolerated or especially likely to reinfect the wound. They were influenced by the fact that the removal of intrapulmonary projectiles was less grave in its consequences when the inflammatory process had subsided. Although they rarely practiced primary extraction in cases of infected pleurae, yet they were forced to undertake it in five cases. In five other cases the projectile was removed in the course of thoracotomy for pleural suppuration. In searching for foreign bodies the rib-spreader of Tuffier helps greatly.

Peihu and Daguet, in a paper upon the late results of gunshot wounds of the chest, found that 27 of 146 cases under examination were bearers of intrathoracic projectiles. These were apparently well tolerated and around them could be seen no modification of the radioscopic image. These writers believe that the clinical signs are of much less importance than those signs revealed by X-ray examination.

Olivier, in a study of thirty cases of gunshot wounds of the chest in which projectiles were retained in the lung, subjected fifteen to operation. The small size of the foreign body and the absence of symptoms contraindicated intervention in some cases. In others patients refused to subject themselves to operation, believing that they were doing sufficiently well. Of the fifteen who accepted operation, some did so because of the anxiety which the projectiles, imbedded in their chests, seemed to cause. Two of Olivier's cases are worthy of note. In one hemorrhages were brought on by a slight effort. In another, in addition to repeated severe hemorrhages, there was a constant expectoration of foul pus. In both the general health was seriously affected. The first case was subjected to operation with cessation of the haemoptysis. The second case declined operation.

One may often be surprised in operating upon these cases at the very slight extent of the pulmonary lesions. A varying degree of adhesions are usually present. The projectile is very frequently surrounded by a thin sack, well limited, and immediately outside this the area of pulmonary tissue becomes healthy. On the other hand, a condition quite different may be encountered if the foreign body is the cause of symp-

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toms. There may be an intense local reaction, the sack being less clearly limited. Sometimes an abscess is found surrounding the foreign body.

A retained projectile may easily become the cause of abscess of the lung or pulmonary gangrene.

The history of surgery of the lung has been dominated by the fear of pneumothorax. That little danger attaches to this has been demonstrated by the experience of Duval and others, who, in their search for projectiles, have performed wide thoracotomy.

When a sufficiently long period has elapsed between the infection of the wound and operation, mortality will be slight. Thus, Marion, in one hundred and fifty cases, had but one death. The final results apparently warrant its practice in those cases in which projectiles produced symptoms of pulmonary reaction, hemorrhages, and purulent expectoration. Cases which have been operated upon and examined five months later presented a functional condition identical with, or less satisfactory than, that which had preceded operation, excepting in those cases in which haemoptysis and purulent expectoration had been present.

Colonel G. E. Gask, D. S. O., Consulting Surgeon to the British Expeditionary Forces in France, agrees that all large missiles (by this is meant a shell fragment about 1 by  $\frac{1}{2}$  inch) should be removed at an early date, namely, during the first two or three days after injury.

According to Duval, the mortality of wounds of the lung from portions of the shell with retention of the missile is 28 per cent. Duval was an early advocate, beginning with personal experiences following the battle of the Somme in 1916, of treating all wounds of the lung by excision of the wound, complete cleansing of the pleural cavity, excision of the parietal wound, and primary suture of the chest. He is of the belief that every wound of the lung which, on fluoroscopic examination, shows a large intrapulmonary haematoma should be operated upon, because it almost invariably becomes infected. According to his latest statistics for operations not urgent he has operated upon but eighteen cases out of one hundred and eighteen. He considers the favorable time for operation on the lung as soon as possible after the injury, and after thirty hours it is, as a rule, not advisable to perform any operation.

Prior to 1916, in a series of three thousand cases, excluding a large number of deaths which occurred in the very advance posts and in base hospitals, the general mortality in evacuation hospitals and advanced dressing stations reached 30 per cent. The predominating causes of death were hemorrhage, mechanical disturbances of respiration from open thorax and, above all, infection of the lung and pleura.

The serious complication of chest wounds, then, is infection of the pleural cavity. These wounds are contaminated with the same germs that infect other war wounds. A very rapid traumatic gangrenous pleurisy, which kills in forty-eight to seventy-two hours, is probably due to organisms carried by the projectile itself. It must not be forgotten,

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however, that streptococci, as well as those organisms which are the normal inhabitants of the bronchial tree, are also present.

If a foreign body is present in the chest the surgeon himself should verify localization. This is more important in the parietes than in the lung. It is desirable to know the presence and extent of adhesions. Major G. Grey Turner, R. A. M. C., employed a simple plan which has proved useful. A straight needle 3 inches long is thrust into the lung and its excursion noted. If there are no adhesions present the needle follows an up and down course a distance of  $\frac{1}{2}$  to 1 inch with each respiration. Depending upon the extent of adhesions the excursion of the needle will be seen to be absent or much limited. Turner advises operation in penetrating wounds with retained foreign bodies in the pleura or lung, if there are definite irritative symptoms leading to disability or continued discomfort, and in those cases in which the removal of the foreign body would rid the patient of anxiety preying detrimentally upon his mind. He hesitates to operate when localization shows the foreign body in or near the hilus.

As regards the treatment of hæmorthorax, we should content ourselves with aspirating as completely as possible and make every effort to detect early signs of infection at the earliest possible moment by repeated bacteriologic examination. Infection having developed, the chest should be emptied of all blood and clots by excision of an inch of rib and insertion of a tube. It is believed to be better surgery if operation is performed within a few days after injury to do a wide thoracotomy, cleanse the pleural cavity, and close the chest, keeping the pleural cavity subsequently dry, if necessary, by repeated aspiration. In this way the chest may remain closed, the lung is allowed to expand, and respiratory distress is lessened. If, however, the infection persists, the wound may be reopened and the tube inserted. We may summarize the indications for operation in gunshot wounds of the chest as follows:

1. Foreign bodies in the parietes, with or without sinuses.
2. Foreign bodies in the lung, irrespective of size, if associated with persistent cough, hemorrhage, or suppuration.
3. Large foreign bodies in the lung, even if the symptoms are purely nervous.
4. All foreign bodies in the pleura, with or without empyema.
5. All cases of infected hæmorthorax.
6. All cases of through-and-through wounds with shrinking of the side, lessened lung expansion, and interference with movements of the diaphragm in which treatment by exercise, et cætera, has failed.

### AUTOPSY RECORDS OF GUNSHOT WOUNDS OF THE CHEST

CASE I.—Private P. P., No. 2981368, Co. M, 7th Infantry, aged twenty-three years.

Wounded October 11, 1918. Multiple gunshot wounds. Extensive pneumothorax of the right chest with emphysema of the sub-

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cutaneous tissues. Disappearance of liver dullness. Apex beat two fingers to left of nipple line. Aspiration of pleural cavity showed a large quantity of foul-smelling yellow fluid and defibrinated blood. Death. Autopsy.

The wound of entrance was about two inches below the clavicle, slightly outside the nipple line, between the first and second ribs. The bullet had fractured the second rib, passed through the upper and middle lobe of the lung, passed downwards and backwards, leaving the thorax in the mid-axillary line. It fractured the eighth and ninth ribs and, passing through the skin between the tenth and eleventh ribs, it reentered the buttock slightly posterior to the anterior superior spine of the ilium. Empyema of the right thorax. Traumatic diaphragmatic hernia containing 6 to 8 inches of the proximal end of the transverse colon. Pericarditis by extension. Slight laceration of the liver. Collapse of the right lung.

Postmortem examination showed an under-nourished individual. On opening the abdomen the hepatic angle of the colon could not be located and was later shown to have become herniated through the diaphragm. The pleural cavity contained about 200 c.c. of yellow-green, putrid pus. The right lung was collapsed and on section contained no air. It was covered with a thick, greenish-gray exudate. The bullet had traversed the anterior part of the upper lobe. The posterior surface of the right lower lobe had been slightly lacerated by spicules of bone from the rib. About 8 inches of colon were found in the right thorax, protruding through a rent in the diaphragm.

Upon opening the pericardium there was a slight increase in the amount of fluid and a fibrinous deposit on the mesial side of the parietal pericardium. This had extended from the pleura. The stomach and intestines were normally placed with the exception of the hepatic flexure of the colon, as noted above. There apparently had been no obstruction of the bowels.

The upper part of the right lobe of the liver had been slightly injured by the passage of the bullet through the diaphragm. The gall-bladder, genito-urinary system, pancreas, thyroid, adrenals, and brain were normal.

CASE II.—Private J. V. H., No. 1757896, Co. D, 312th Infantry, aged twenty-five years.

Wounded October 18, 1918, when he received a gunshot wound which penetrated the left lung. He entered Base Hospital 61 October 19. The wound of entrance was above the spine of the scapula posteriorly, and the wound of exit in the second interspace in the mid-clavical line. Râles were heard over the left lobe, posteriorly. Pneumothorax. Dullness over the right lower lobe. Fluid in the right pleural cavity. Symptoms of meningitis. Death. Autopsy.

Anatomical diagnosis: Acute purulent meningitis due to Gram-negative diplococcus. Fracture of the first and second ribs, penetrating bullet wound of the right chest. Subscapular abscess connected with a localized empyema at the apex of the right pleural

cavity. Hæmorthorax. Atelectasis of the right lower lobe. Subacute parenchymatous nephritis. Chronic endocarditis of the mitral valve, with stenosis. Acute cholecystitis.

The right lung was very firmly adherent to the base. There was a large, bulging mass at the apex, about the size of a man's fist. The lung was firmly adherent to this. This mass was opened and was found to be filled with pus. The left lung was free and no fluid was present. The bronchi were intensely congested and contained some pus. On section, the right upper lobe of the lung contained many consolidated lobules. This appeared to originate by extension from above. Right lower lobe was very small and collapsed and contained no air. The left lung contained air throughout. The mediastinum contained large, swollen lymph-glands and showed considerable oedema.

Circulatory system. The valves were free and soft except the mitral, which showed a distinct vegetation, causing stenosis. There were yellow, elevated nodules on the aorta around the openings of the intercostal vessels.

On section the kidney capsule stripped with considerable difficulty. The surface was torn. They cut less easily than normal, apparently due to an increase in connective tissue. There was a considerable plastic exudate around the gall-bladder. It was adherent to the duodenum. The pancreas, the adrenals, the liver, thyroid and the bones and the gastro-intestinal systems were normal.

Upon examination of the brain there was a slight exudate along the course of all the vessels, especially in the Sylvian fissure and on the inferior portion of the cerebellum.

The course of the bullet was traced from the supraspinous fossa on the right side of the posterior chest, passing through the chest wall and fracturing the first and second ribs on the left side. There was a marked infection along the course of this tract. The large pus pocket at the apex of the right lung was connected with another large pus pocket in front of the right scapula. Infection had extended to the periosteum of the spinal column and apparently affected the central nervous system by direct extension.

Bacteriology: Cultures from the heart blood showed no growth. From the abscess at the apex of the lung streptococcus and pneumococcus. Smears from the brain showed a Gram-negative diplococcus.

**CASE III.—Private E. B. C., Co. I, 308th Infantry, aged twenty-four years.**

Lacerated gunshot wound of the right chest. Empyema. Collapse of the right lung. Infraction of the spleen. Death. Autopsy.

Admitted to Base Hospital 61 October 7, 1918. Wound of the right chest penetrating at the fifth interspace in the anterior axillary line.

This extended from the nipple to the costal margin. A counter opening was seen at the eighth interspace in the posterior axillary line.

Much mucus in the left bronchus. The right lung had collapsed

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completely and was firmly adherent to the diaphragm and mediastinum. This was firm and contained no air and was beef-red in appearance. The pleural cavities were covered with a thick, yellow, fibrinous exudate. There was a large communication with the exterior, admitting two fingers easily through the fourth and fifth interspaces. The fifth rib had been broken and partly removed. The bullet left the chest about the eighth interspace. The circulatory system, gastro-intestinal system, genito-urinary system, liver, thyroid, adrenals, and brain were normal. The spleen was one and one-half times its normal size. The capsule was not thickened and on section was very soft and congested.

CASE IV.—Private D. C. J., aged twenty-five years, Co. C, 324th Machine Gun Battalion.

Wounded November 10, 1918. Bullet penetrated the soft parts of the left upper arm, entered the left chest below the axilla. Admitted to Base Hospital 61 November 14. Wounds dressed and drainage tubes inserted. His general condition was poor. Temperature, 104°. Dullness of the left lobe. Aspiration in the sixth interspace. Much foul-smelling gas removed. Wound culture showed an anaërobe. November 24, patient delirious, in extremis. Died the following day.

Anatomic diagnosis: Empyema. Collapse of the left lung. Broncho-pneumonia. Fracture of the left fourth rib. Gunshot wounds multiple, penetrating left chest. Retained foreign body.

There was a penetrating wound on the external surface of the left arm, which passed posteriorly to the humerus. There was a ragged, superficial wound on the lateral surface of the thorax in the left mid-axillary line at the level of the fourth rib.

The left pleural cavity contained about 600 c.c. of frothy, foul-smelling pus. The lung had collapsed and was firmly adherent to the mediastinum and diaphragm. The lower end of the trachea and bronchi were very congested and contained considerable sero-sanguinous material. The left lung was covered with a thick, black exudate. The lateral surface, half way between the base and the apex, was lacerated. The terminal bronchioles were much dilated. The middle lobe was the same as the upper and there were some dark, depressed alveolar outlines. Many were consolidated along the inferior and posterior surfaces. These areas were dark red, stood out distinctly from the surrounding air-containing tissue, and sank rapidly in water.

Circulatory system, gastro-intestinal system, and genito-urinary system normal.

The liver was about one and one-half times its normal size, enlargement chiefly confined to the left lobe. The surface was very mottled, with yellow edges, and on section this presented a distinct nutmeg appearance. Other organs normal.

Bacteriology: Heart's blood showed a non-haemolytic streptococcus. From the lung was obtained a Gram-negative, motile, putrefactive bacillus (undetermined), staphylococcus and streptococcus.

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CASE V.—Corporal A. W., No. 735837, aged twenty-two years, Co. F. 11th Infantry.

Wounded November 5, 1918, at 6 A.M. Diagnosis: Gunshot wound of the left lower chest and upper abdomen. At operation eight hours later, the upper abdomen was found filled with blood. The pleural cavity was cleansed and the lacerated spleen removed. No evidence of injury to the intestines. Closure of the abdominal wound with rubber-tube drainage. Intravenous saline. Patient in poor condition. November 12 a large amount of sloughing tissue was removed.

November 14 he was admitted to Base Hospital 61. The sutures had pulled out and the entire wound was open for a distance of 8 inches. Cultures from the wound showed streptococcus and an anaërobe. November 19 the wound was partially drawn together with heavy through-and-through silk sutures. November 24 signs of a right broncho-pneumonia.

Gunshot wound of the chest in the mid-scapular line, fracturing the eleventh rib. Wound of the abdomen in the left hypochondriac and lumbar region. Collapse of the left lung. Empyema left, acute fibrinous pleurisy, localized peritonitis, hæmolytic streptococcæmia.

Postmortem examination showed an emaciated individual. A large suppurating wound on the anterior abdominal wall. There was a large wound perforating the thorax, through the space occupied by the eleventh rib.

The intestines were adherent to the anterior parietal peritoneum. Localized peritonitis limited to the intestines subadjacent to the wound. Adhesions were easily broken up. The spleen had been previously removed. There were many adhesions in this region.

The left lung had collapsed. There was no pus in the pleural cavity, but a thick, fibrinous exudate on the visceral and parietal pleura. The right lung was very voluminous and the posterior part of the lower lobe was slightly reddened and showed subpleural hemorrhages. On section the upper and lower lobes were air-containing throughout. The lower appeared reddish on the surface and on section sero-pus escaped. The left lung was about one-third its normal size. The parietal pleura was removed with the diaphragm. It was very thick and tough, like shoe leather, as was the visceral pleura. Both surfaces were covered with much fibrinous exudate. The pleural cavity had evidently been the seat of a marked suppurative process, which had drained out completely through the opening of the thorax. The lower and posterior parts of the lobe were consolidated. The inferior surface was firmly adherent to the diaphragm. The genito-urinary system, pancreas, and adrenals were normal. The thyroid was much enlarged and gave the appearance of colloid degeneration. Some loops of the ileum were adherent to the colon and the abdominal wall. There was no ulceration or obstruction. The cæcum and transverse colon were evidently involved by direct extension from the wound. On section the liver showed some evidence of cloudy swelling.

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The surface of the brain was much congested and there was a brown spot 5 cm. long and 2 cm. wide on the inferior surface of the frontal lobe, involving the extreme anterior portion. This appeared to be the seat of an old hemorrhage.

Bacteriology: Heart's blood showed haemolytic streptococcus, abdominal wound staphylococcus, Gram-negative and Gram-positive diplococcus. From the lung haemolytic streptococcus and staphylococcus were recovered.

## OPERATIVE RESULTS IN TWO HUNDRED BREAST TUMORS \*

BY BYRON B. DAVIS, M.D.  
OF OMAHA, NEB.

My private records of operations for growths of the breast contain the histories of 166 persons suffering from malignant tumors and 44 from benign. In this series no cases have been included that were operated during the last three years, and the records cover my private work from 1898 to December, 1916. The records of many other cases operated are inaccessible or so incomplete as to be valueless. The cases included have practically all of them been verified by the microscope in the hands of a trained pathologist.

Of the 166 cases of malignant disease that an effort has been made to trace there was one operative death, the remaining 165 having left the hospital apparently in good condition. One hundred and sixty-five were diagnosed as carcinoma and only one sarcoma was found. All but one occurred in women.

My letters were sent to the husband, son, daughter, or physician, and not to the patient, as it was felt that this method would most likely bring answers in the event that the patient had died. To the 165 letters sent out answers have been received thus far from 101. Up to the present, 64 have failed to answer and these cannot be used for statistical purposes.

Of the 101 answers received 63 may be considered free of the disease for periods ranging from three to about twenty-one years. Of the 38 remaining 36 have died of local or disseminated cancer, and two yet living are suffering from recurrence. Three or four reported dead were not considered by their relatives to have died of cancer; one was called "creeping paralysis," one "from a stroke," etc., but these were obviously deaths from cancer and are so included.

This gives us, then, the rather encouraging result of a little better than 62 per cent. of the cases free of recurrence from three to twenty years. I refrain from using the word "cured" in this connection, for there have been a number of cases that have remained free of any evidence of the disease from five to nine and one-half years and have then recurred and died of the disease, and there is little doubt that some of the cases reported free of all trouble now will later succumb to the disease. For this reason it is freely conceded that 62 per cent. is not a fair estimate of cures obtained. It is also only fair to presume that among the 64 not heard from the proportion of deaths is larger. It is only natural that the friends of the living would be more likely to answer the questions propounded than the friends of the dead.

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\* Read before the Western Surgical Association, Dec. 6, 1919.

## OPERATIVE RESULTS IN BREAST TUMORS

Allowing for all sources of error we have 63 very favorable results, and this means a good many years of life and health and, it is hoped, happiness in the aggregate.

Under benign diseases of the breast there have been included 44 cases. Two cases that were considered benign at the first operation later appeared with carcinoma and underwent the radical operation. Whether the diagnosis first made was erroneous or the malignancy was of later development it is impossible to say. Forty of the benign cases were in females and 4 in males. Under the caption adenoma, fibroadenoma, and cystadenoma there were 37, and one with mastitis complicated with adenomata. In 3 of these cases both breasts were involved and the tumors excised from both. In two cases after the adenoma had been excised from one breast it appeared in the other and was excised, and in one case a second adenoma was later excised from the same breast.

The treatment of the adenomata in females was simply excision, usually through an incision along the thoraco-mammary junction, the breast being turned up and the tumor removed from underneath. In two cases of multiple fibroadenoma the disease was so extensive that simple amputation of the breast was done, and in two other cases before I made a regular practice of having a frozen section made immediately in all doubtful cases, I did the radical operation under the impression that it was carcinoma. Later these two cases were shown microscopically to be benign and are so counted. In each of the four male cases the breast was amputated.

In the cases mentioned of mastitis complicated by multiple adenomata the breast was amputated as was also done in three cases of generalized chronic mastitis. There were also two cases of lipoma that were simply enucleated and one case of mammary tuberculosis in which the breast was removed.

The average age of those having benign growths was thirty-four years, while the average age of those suffering from carcinoma was forty-seven and one-half years. The surprisingly large number of women with carcinoma between the ages of thirty-five and forty-five and the small number past sixty brought the average below that usually given.

For some time I have been under the impression that the propaganda being carried on by the "Society for the Control of Cancer" and by the medical profession generally is bringing women with cancer of the breast to the surgeon much earlier than formerly. From this standpoint my statistics are truly disheartening. The time the growth was first noted is given in almost all the histories. The average time between the discovery of the "lump" and the day of the operation in those operated before 1910 was one year, three months, eight days, while those operated during the years 1910 to 1916 were aware of the growth one year, five months, eight days before the operation, a difference in favor of the earlier group of exactly two months. A partial explanation of this apparent lack

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of progress is that in the 1910 to 1916 period are included two women with tumors of thirty and fourteen years' standing, respectively. Leaving these two cases out of consideration it would bring the average duration of the later period down to a little below that of the earlier.

Statistics are peculiar things. It is also found that the average time between the discovery of the "lump" and the operation of those that died of recurrence is practically the same as of those that have remained free of the disease. These apparently contradictory figures should not lessen our determination to operate as early as possible in every case. The discovery of the "lump" is in most cases purely accidental, and it bears little relation to the beginning of the disease. Every surgeon frequently operates on tumors only recently discovered that show advancement and must have been well started months before the date of discovery. It is evident that in most cases carcinoma of the breast antedates its discovery weeks and months and sometimes years.

There was one operative death, Mrs. N., of Valentine, Neb., aged seventy years, referred by Dr. Alfred Lewis. Had carcinoma of the right breast, well advanced and of five years' duration. Her condition seemed satisfactory, and the usual radical operation was done October 23, 1912. She died October 25 of suppression of urine.

Another case was a tragedy. Mrs. R., aged sixty-one years, had carcinoma of the right breast with great axillary involvement. She was operated June 21, 1910. In dissecting some adherent glands from the axillary artery the artery was punctured. The wound was sutured as carefully as possible, but at the close of the operation no radial pulse could be felt. The arm was wrapped in cotton and kept as warm as practicable, but gangrene of the forearm occurred, and July 6 the arm was amputated at the junction of the middle with the lower third. She recovered nicely from the operations but died of recurrence of the cancer eleven months later.

For the past eight years it has been the regular procedure to have a pathologist present in all doubtful cases who makes a frozen section of the removed tumor. In from three to eight minutes he is able to make a fairly thorough study of some sections. If he finds a definite picture of malignancy the radical operation is done at once; if he fails to discover malignancy the little wound is closed. This combination of the macroscopic study of the growth and the microscopic examination is fairly free from error, but not as certain as a careful laboratory study of the case made at leisure. To combat this source of error the tumor is taken to the laboratory later and prepared in the usual way and many sections are studied. In two cases of this series that appeared benign at the hasty frozen-section examination, malignant areas were discovered later and radical operation was done.

In this series are many cases that have had local recurrences which have been removed by later operations. It is fair to state that most of

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the cases requiring secondary operations have subsequently died of the disease, but this has not been true of all of them. Even if all of this class had finally died operations for local recurrences prolong life and keep the patient hopeful. Several with one or more recurrences that were promptly removed are still alive and well and free of any evidence of disease a number of years after their last operation. As an example of what may be done: Mrs. R., aged forty-six years, was operated for a carcinoma of the right breast of four years' duration, November 22, 1909. A nodule appeared in the scar and was removed by a wide dissection July 28, 1910. Still another recurrence along the line of the scar was removed April 1, 1911, about eighteen months after the first operation. She came to my office a few months later and the scar was nice and smooth and gave no sign of any active process. About this time she moved to Chicago. On October 19, 1919, a letter from her husband stated that she is alive and well and had had no further evidence of the disease since her last operation, eight and one-half years before.

Cases of this kind give one courage to persist in removing these local recurrences when the outlook is darkest. One should make as great an effort to get rid of a recurrence radically as if he were dealing with the primary disease.

Among the 166 cases in this series one woman presented herself with carcinoma of both breasts that had developed simultaneously. Radical operation was done on both sides February 22, 1904. She was alive and well and free of recurrence a year ago, the last time I have heard from her.

In the series were seven patients operated for carcinoma of one breast who subsequently returned with carcinoma of the other for which radical operation was also done. Five of them died subsequently of cancer and two are alive and well six and one-half and seven and one-half years, respectively, after the second breast was removed. When a carcinoma permeates the lymphatics inward to the sternum it may be carried by the anastomosing lymphatics across the front of the sternum to the opposite breast and axillary glands, and really when the permeation pursues this course it is not of much graver significance than to be carried to the lymphatic glands on the side in which it originates.

The youngest case in the series was a girl only eighteen years old. Only a few days before she appeared for an operation a "lump" was discovered in the left breast. It was almost "woodenly" in feel and had all the clinical characteristics of a typical carcinoma. A frozen section from the tumor, removed June 8, 1916, was pronounced by Doctor Manning to be carcinoma and the radical operation was done. The later study of numerous sections confirmed this diagnosis. It was clinically, macroscopically and microscopically an adenocarcinoma. This girl has been lost sight of.

There was in the series one case of sarcoma operated October 16, 1916. Two local recurrences were removed the first six months after the radical

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operation. A letter from the husband, written October 25, 1919, states that she is in the best of health and there is no sign of the disease.

Most of the cases operated the past ten years have received X-ray treatment. I am not able to make any positive assertions concerning its effects. About all I can say is that it seems a mildly palliative measure, and should be used vigorously after every operation for mammary carcinoma.

A few years ago it seemed that the ultimate had been reached in the surgical management of carcinoma of the breast. The ideas promulgated by Handley have produced some modifications that promise to lower the final death-rate still more. Formerly about all we had in mind was to remove the breast, the pectoral muscles, and fascia widely and to clean out the axilla with the feeling that the avenue of dissemination outside of infiltration and metastasis was *via* the lymphatics leading to the axilla, and sometimes the enemy would make a counter attack on the mediastinum, the lungs, the liver, or some other vulnerable point for which the surgeon did not blame himself because he considered these attacks embolic and involvement of these regions meant metastasis *via* the circulation.

It seems that Handley's views that the chief method for the dissemination of cancer is by the cells growing along the lymphatic vessel lumina, and that they can as readily grow downward and penetrate the abdominal wall in the epigastric angle and reach the liver or the peritoneal cavity, or by growing along the lines of communication towards the sternum and passing backward in lymphatics that accompany the internal mammary vessels to the mediastinal space, or by growing along the anastomosing lymphatics from the opposite side may reach the other breast, are correct. Still other routes may be chosen. Knowing the lines of most active permeation will naturally influence the form of operation.

The removal of large areas of skin as formerly practised does not now seem necessary. Most recurrences in the skin have been shown to be extension of the process upward from the so dangerous fascia. Any tissue that is abundant in lymphatics is a menace, because the lymphatics have been shown to be the most travelled routes by which cancer is disseminated. Hence the most extensive removal of deep fascia and muscles extending not only to the axilla with the removal of its fat and glands, but extending inward past the border of the sternum and downward to the epigastric region, in order to cut off the different lines of advance of the cancer cell, is the logical procedure.

To have a set form of incision I am satisfied is a mistake. The location and extent should determine the line of incision and the amount of skin to be removed. If the growth is deeply seated only a comparatively small amount of skin need be sacrificed. If near the surface, and especially if the skin is adherent, a much larger area should be removed.

The most methodical part of the operation, as well as the more extensive, occurs beneath the skin. There is really no especial limitation to the amount of fascia and fat that may advantageously be sacrificed. In

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the fascia one may be reasonably certain that there is microscopic invasion much farther than is macroscopically apparent.

Volkman's three-year period of freedom from recurrence does not constitute a cure of cancer. Neither does a five-year period. A number in this series were free from recurrence more than five years, but later died of cancer. The longest period noted in any of them was a woman, operated October 31, 1904, at the age of sixty-eight. She was apparently free of all trouble until early in 1914, about nine and one-half years after her operation, and she died of the disease in December, 1918, more than fourteen years after her operation. I examined this woman several times and the recurrence came in the form of nodules over the chest wall, formerly occupied by the breast, and was a typical local recurrence and not a carcinoma originating as a primary growth. At least, that is the way it appeared to me.

In conclusion, my study of these cases and the results obtained are encouraging rather than discouraging. Operation for cancer saves lives. The very early operation, so early that the microscope is necessary to make the diagnosis, is bound to produce better results than the operation done after the disease is easily diagnosed. The radical operation should be directed in such a way as to remove as thoroughly as possible the highways along which the disease is disseminated.

The campaign of education of the public with reference to the signs of early cancer and its curability when operated early should be continued and kept up unceasingly. And finally the fact should be appreciated that every woman operated for carcinoma of the breast who remains free of the disease is more powerful propaganda in the community in which she lives than all the tracts that could be written.

## DIAPHRAGMATIC HERNIA\*

BY THEODORE F. RIGGS, M.D.

OF PIERRE, S. D.

PROTRUSION of a portion of the abdominal viscera through an opening in the diaphragm, while by no means unknown, is perhaps more frequent than we realize. According to Giffin,<sup>1</sup> about 650 cases of diaphragmatic hernia had been reported in the literature up to 1912, and eighteen articles on this subject, from the point of view of the radiologist or surgeon, have appeared during the past two years. Since many of the diagnoses have been made only in the autopsy room and as a number of patients have been operated upon with the hernia unrecognized and unrelieved, it is probable, as Soresi<sup>2</sup> so clearly points out, that many a person is in discomfort to-day because of the failure to recognize the true condition present.

According to the authorities the great majority of diaphragmatic herniæ occur to the left of the midline. The case herein reported we believe to have been a true traumatic hernia on the right of the midline.

The patient, a woman, aged thirty-four years; weight, 170 pounds; height, 66 inches; was admitted to St. Mary's Hospital December 1, 1918. Complaint: Vomiting ten to sixty minutes after nearly every meal. Family and personal history unimportant except that the patient has been strong and active, doing hard physical house and farm work. Present trouble began about two and one-half years ago and has been gradually increasing. The patient ascribes the beginning of her trouble to carrying a wash-tub nearly full of water. This she carried some fifty feet with the side of the tub resting against her abdomen. While carrying the tub she noticed a sharp rather sickening pain in the upper abdomen or in the angle of the ribs, which pain almost wholly ceased when she emptied the tub and was relieved of the weight. She, however, did no more work that day because of persisting nausea with a few unsuccessful attempts at vomiting. The next day she was seemingly as well as ever and for a time continued to do her usual work, but without attempting to repeat the tub-carrying incident. Recurring attacks of mild nausea and eructation at various intervals were noted during the first year, gradually increasing in frequency, and during the past year and a half the nausea and belching has been followed more and more by vomiting, until during the past six months the nausea has almost ceased and the vomiting has been noted to occur within ten to sixty minutes after nearly every meal. The vomitus consists of the food ingested, but rarely, if ever, has the patient vomited all of the food taken. There has been no appreciable loss of weight or

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\* Read before the Western Surgical Association, December 6, 1919.

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strength. There has never been any severe pain since that at the onset. No blood has been in the vomitus nor, so far as known, in the stools. Liquids were perhaps less likely to be vomited than more solid food. The bowels have always been somewhat sluggish and the patient thinks that during the past year this sluggishness has increased. Menstrual history negative; the possibility of a pregnancy or of a pelvic tumor or inflammation was carefully considered and eliminated.

Examination showed a rather pale, well-developed, well-muscled, rather fleshy young woman. Temperature repeatedly normal. Haemoglobin, 70 per cent.; leucocytes, 7600; blood-pressure, systolic, 134; diastolic, 80-85; urine normal. Test meal an hour after eating showed a free hydrochloric acid of 26 and a total acidity of 49. A second specimen taken thirty minutes later gave hydrochloric acid 23 and a total of 31. Digestion poor and there was considerable mucus. In the chest the lungs were clear and there was no restriction in respiratory movement. The heart sounds were normal, but the area of cardiac dullness and the apex beat were noted to be about one finger breadth higher than normal. Although the chest was separately examined by two of us there was no area of tympany found. The abdomen was fleshy, full, and soft, with no tender area except on deep pressure beneath the costal border in the gall-bladder region. The stomach outline was high but not unusually so, and there was no unusual dilatation or discomfort on filling the stomach with air. The capacity of the stomach was about 750 c.c., as noted on lavage.

Following a barium meal the X-ray showed a high stomach, but very unfortunately the margin of the first plate came too low to include the pylorus. The second picture taken an hour later shows the barium passing upward and to the patient's right through a constricted area proximal to the pylorus. The patient vomited approximately half of the meal, and the succeeding bowel pictures were not satisfactory. That we did not fully appreciate the second picture is shown by the fact that our choice in the a. o. diagnosis was a secondary gastric upset due to adhesions resulting from an old ulcer. Looking backward it is easily seen that we should have made a correct diagnosis.

Operation December 11, 1918, under ether anaesthesia. Incision over upper right rectus. Gall-bladder and appendix normal. The peculiar fact was noted that no omentum and no transverse colon could be seen on first examination. A portion of the greater curvature of the stomach was visible, but its margin was almost parallel to the incision. On following the colon from near the hepatic flexure what should have been the transverse colon was found to pass upward and to the left of the gall-bladder where it was parallel to, and slightly behind, the greater curvature of the stomach. The right and left lobes of the liver were widely separated along their lower margin just to the left of the point of juncture of the falciform ligament. The transverse colon and the stomach were found to pass

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upward in this separation of the liver and to pass through an opening in the dome of the diaphragm slightly to the right of the midline. Considerable difficulty was met in withdrawing these organs from the opening in the diaphragm, but when accomplished it was found that the contents of the hernia consisted of the pyloric portion of the stomach, the greater portion of the transverse colon and almost the entire omentum. Following the removal of these organs from the diaphragmatic opening, the patient at once ceased to breathe, but respirations were resumed when pressure was made closing the abdominal incision. The incision was then extended upward along the costal border to the midline and the hand was easily passed through the opening in the diaphragm. As nearly as could be told the cavity occupied the posterior part of the mesial portion of the right half of the chest. The heart could be felt pulsating to the patient's left and the lung tissue resistance could be felt anteriorly, to the outer side and above the hand. Posteriorly the ribs and bodies of the vertebrae could be easily felt through a thin layer of soft spongy tissues. There was a definite sac, but whether composed of two layers, the peritoneum and pleura, it is impossible to state. The opening in the diaphragm had its long axis anteroposteriorly and there was a distinct continuation of the diaphragm for at least two inches anteriorly and one and one-half inches posteriorly beyond the ends of the hernial opening, which easily admitted the examining hand and was fully three inches long. To close the hiatus four double sutures of No. 3 plain catgut were passed through the two pillars or margins of the opening, leaving the ends long, until all sutures had been placed, when they were tied. To insure a more permanent closure a portion of the omentum was lifted up and sutured over the opening. To pass the sutures in the diaphragm it was necessary to elevate the costal border, whereupon respiration would cease. It was therefore necessary to pass one stitch and close the abdominal incision by pressure until respiration was reestablished before attempting a subsequent suture. In the passage of one of the sutures the needle evidently punctured the pericardium or possibly touched the heart, as there resulted a sudden violent tachycardia. Needless to say, that needle was promptly withdrawn. Final closure of the diaphragmatic opening was apparently sound, for the abdominal incision could be held open without affecting the respirations. One small roll rubber drain was placed in the upper end of the incision with its tip carried down nearly to the line of suture in the diaphragm and the abdominal incision was then closed. Convalescence was uneventful except that during the second week the temperature ranged between 99° and 101°, probably due to a collection of fluid in the hernia cavity as was evidenced by relative dullness in this region. Whatever the cause, it gradually quieted down and the dullness disappeared. The displacement of the heart upward as noted before operation was entirely corrected and was doubtless due to the pressure of the displaced abdominal viscera. The patient was discharged from the hospital on January 5, 1919,

## DIAPHRAGMATIC HERNIA

but was again seen on February 26 when a barium picture showed the stomach in normal position. There has been complete relief from the symptoms.

That the hernia was of traumatic origin we believe the history shows. That the opening was to the right of the midline we are certain. That the condition was not an elevation or relaxation of the diaphragm is proved by the definite limits of the opening. That the rupture was not through one of the normal openings in the diaphragm was shown by its position and the fact that no tissues passed through the ring other than those named.

Of the presence of a hernial sac or membrane we are sure, although we cannot be certain it was not a false sac developed by the long standing hernia. However, because the hernia evidently did not reach its maximum size at onset, because there were no adhesions of the viscera in the sac, and because the pillars of the split in the diaphragm were so evidently covered with peritoneum, we feel justified in believing the hernia to have been a true one, namely, contained in a sac formed by the diaphragmatic peritoneum and the diaphragmatic pleura.

If it be true, as seems likely, that the profession is not making as high a percentage of correct diagnoses in diaphragmatic hernia as in other more frequent abdominal conditions, the failure is probably due to lack of a sufficiently definite symptomatology. DeCourcy<sup>3</sup> has formulated a few symptoms which point to non-traumatic cases of diaphragmatic hernia. Soresi<sup>2</sup> discusses fully the difficulties of outlining the symptoms characteristic of small diaphragmatic hernias which he says are never diagnosed, and he urges careful routine examination of the diaphragm. A comparison of the cases reported by Beckman,<sup>4</sup> Giffin,<sup>1</sup> DeCourcy,<sup>3</sup> and others brings out clearly the variations in, and the multiplicity of, the symptoms.

This is to be expected when one considers the many combinations possible, depending upon the location of the hilus and the viscera involved. It is reasonable to expect the traumatic hernia to be more easily diagnosed than the non-traumatic form, but one must remember that the severity of the symptoms is not necessarily in keeping with the size of the hernia. The possibility of a diaphragmatic hernia should, perhaps, be more often considered.

<sup>1</sup> Giffin, H. Z.: *ANNALS OF SURGERY*, 1912, vol. Iv, p. 380, and personal communication.

<sup>2</sup> Soresi, Angelo L.: *ANNALS OF SURGERY*, 1919, vol. Ixix, p. 254.

<sup>3</sup> DeCourcy, Joseph L.: *ANNALS OF SURGERY*, 1919, vol. lxx, p. 179.

<sup>4</sup> Beckman, E. H.: *S., G. and O.*, 1909, vol. ix, p. 154.

## CONGENITAL DIAPHRAGMATIC HERNIA\*

WITH REPORT OF A CASE

BY LOUIS FRANK, M.D.  
OR LOUISVILLE, KY.

SCUDDER, in 1912, could find only fifty-three cases of diaphragmatic herniae which had been subjected to operation. Since then a number of cases have been recorded. We must, however, conclude that those of congenital origin are exceedingly rare and do not often come to operation. More rare, for evident reasons, are those, whether congenital or traumatic, occurring on the right side.

A careful review of the literature since Scudder's paper reveals only forty-one additional cases reported, and one of these a personal communication. We are forced to believe, however, from conversation with some of our X-ray friends, that there have been others; but whether they occurred in adults, or whether they ever came to operation, I have no means of knowing.

Of the additional cases recorded in the literature only five were reported as congenital, those observed and operated upon being accounted for largely by the trauma of war. Most of the cases occurred in soldiers as the direct result of missiles. In this type of case, also, it is a fact, explained by the anatomic position of the liver, that the hernia was almost uniformly upon the left side.

A study of these cases indicates that the abdominal method of approach is the most popular. This is easy to understand in cases of traumatic origin where a missile has entered the abdomen primarily. We find, also, that one patient with congenital hernia was subjected to gastro-enterostomy, this being the only feasible procedure to obtain relief from urgent symptoms which were present.

Of the additional cases which I have collected, two were observed post-mortem. One was advised against operation, the pathology having existed without much discomfort, according to the history, for a period of forty-five years, the patient at the time of diagnosis and presentation being fifty-nine years of age.

In the description of diaphragmatic hernia there is nothing to surpass—either from an anatomic standpoint, or from close study and analysis of the symptomatology in both strangulated and non-strangulated cases—that written by Cooper in his classical work on hernia published in 1804. He divides diaphragmatic hernia into three varieties, and I believe his division holds good to-day. He first classifies them into congenital and acquired. Under the congenital type he describes two

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\* Read before the Southern Surgical Association, December 16, 1919.

## CONGENITAL DIAPHRAGMATIC HERNIA

varieties, one in which there is a distinct peritoneal sac, in the other there being no sac. The third variety also has no sac, this being entirely traumatic in origin.

A study of the literature confirms Cooper's opinion that congenital herniae of the second variety are rarely seen, as the subjects usually die at birth or shortly afterward. In the first variety of the congenital type the individual may live for quite a period of years, and in his work Cooper mentions such cases, describing also cases of the second variety and of the traumatic type.

Among the illustrations to be shown in connection with this paper there are three taken from Cooper's work (Figs. 1, 2, and 3). These were selected because of their excellence.<sup>1</sup>

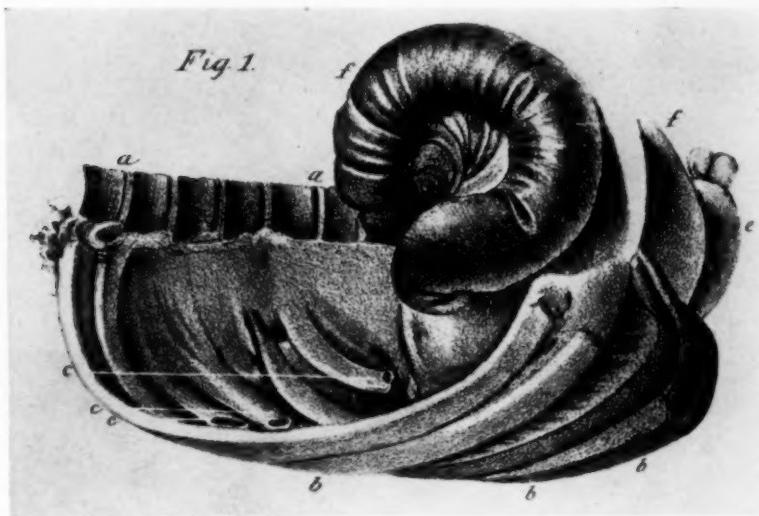


FIG. 1.—Phrenic hernia caused by fracture of the ribs. (From Cooper, "Hernia," 1804-1844.)

Beckman believed that the congenital type could not be benefited by operation, and the opinion was then expressed repeatedly and set forth in text-books on surgery that such herniae should not be operated upon unless they become strangulated, and this seems to have been the general practice. Beckman says the congenital type are not true herniae in that they have no sac. In the face of the reported cases, which have been carefully studied, this contention can hardly be maintained.

Giffin, in 1912, and Scudder in the same year reviewed most carefully and completely all the literature of this subject. At that time about

<sup>1</sup> There is nothing to be found in modern literature which equals the description of the clinical symptomatology of congenital, strangulated diaphragmatic hernia which appears in the work of this famous surgeon of bygone and almost forgotten days. Those interested will find much valuable information concerning the subject of hernia in general in his book published over one hundred years ago.

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one thousand cases had been recorded, though of these a very large proportion had been discovered only at autopsy. Scudder's study showed that there had been about fifty-three operations performed for diaphragmatic hernia at that time, and of this number thirty-nine patients had died. The thoracic approach was used in eleven, of which seven recovered; the abdominal approach in forty-two, of which thirty-five died. In these fifty-three cases deliberate operation based upon pre-operative diagnosis was performed in only six, the other patients applied to the surgeon for relief of intestinal obstruction; and, as he says, this is most

Fig. 2.



FIG. 2.—Phrenic hernia in the fetus. g. g. bougie (passed through diaphragmatic aperture. From Cooper, "Hernia," 1804-1844.)

Fig. 3.



FIG. 3.—Strangulated phrenic hernia in adult. i. a bougie under strangulated colon and omentum. (From Cooper, "Hernia," 1804-1844.)

likely the cause of the high mortality. The case reported by Giffin in 1912 is included as one of the six diagnosed before operation, though, if I read the report of Beckman correctly, three of his cases were also diagnosed before operation. We would recommend the articles of Giffin and Scudder to those who desire to pursue further studies of the literature of this subject.

Recently, as has already been said, probably as a result of war wounds, the subject has again been brought to the attention of the profession particularly by Soresi, in a paper published during the current year. He reports one congenital and two traumatic cases, suggesting a method of closure to insure against recurrence of the hernia. We may say, in passing, that we know from experience it is not always possible to success-

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fully execute a previously planned procedure for permanent cure in these cases. This is also well illustrated by Downes' case of congenital hernia in a boy about seven years of age, where it was impossible to restore the viscera to the abdominal cavity, necessitating, on account of the extreme condition of the child, a gastro-enterostomy to prevent starvation.

Downes believes from his experience that the abdominal approach is better, because in congenital cases where hernia has occurred through a dilated opening it may be impossible to correct the condition by approach from above. In our own case, as the citation will show, it was impossible to successfully deal with the condition through the abdominal incision, necessitating a trans-thoracic operation.

Attention is called by the author last quoted to the possibility of mistaking a full stomach herniated through the diaphragm for pyopneumothorax, and he states that several cases have been recorded in which such a mistake, followed by aspiration, terminated fatally. While in former years there may have been difficulty in diagnosis, we believe to-day with the aid of the röntgenologist and stereoscopic views the diagnosis can be accurately made in practically every case. In our own case no difficulties were presented after a stereoscopic picture was obtained.

Where a large portion of the stomach is herniated, the clinical history is similar to that of hour-glass or obstructed stomach, except that there are periods of remission and the symptoms begin in early childhood. However, the symptomatology, pathology, and etiologic factors have been so fully discussed in the literature that we will not consider them further in this paper, our desire being rather to report an interesting and probably unusual case, with the difficulties confronting us in our efforts at relief.

CASE I.—V. B., aged sixteen years, schoolboy, admitted February 2, 1919. The family history was negative. The boy had not been well since he was eighteen months old, at which time he had not yet been weaned. The mother noticed that he would frequently go the greater part of the day without nursing, and that often after nursing (during these periods) the ingestion of food was followed by vomiting. This was particularly true when he took much nourishment, overfilling the stomach, and was attributed to that cause. Later it was evident that the attacks of vomiting were induced by the recumbent posture. When the child was on his feet and going about he seemed to have less trouble. Vomiting was most frequent at night, and often the mother would remain up with him the greater part of the night on account of his apparent distress and his inability to retain food.

Vomiting was sometimes as frequent as six times daily, then again he would go for two weeks without an attack. For weeks at a time he would vomit food two or three times a week, and then he would be free of disturbance for a week or two. He did not gain rapidly in weight though continuing to grow. What he gained in

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two or three weeks he would lose during the attacks. As a child he had almost constantly borborygmus without distention. This was often very annoying. The sounds were audible to those in the room and were relieved to some extent by belching.

Later as he took solid food he would have little or no trouble for weeks at a time when he would rapidly gain in flesh. For several years he had little trouble except occasional vomiting at night accompanied by much abdominal pain. He was able to attend school, but could not indulge in much exercise for fear of an attack. He subsisted largely on liquid and soft diet taken in small quantities at quite frequent intervals. He never had any cardiac attacks nor respiratory difficulty.

Present illness and condition: The patient comes on account of marked gastric disturbance which is irregular. He is having "attacks with his stomach" two or three times a week. During the attacks he has pain, "bloating of the stomach," and vomiting. He cannot eat without bringing on discomfort. This lasts a while, is followed by vomiting, the vomitus containing food eaten two or three meals previously, and after the stomach is apparently emptied he will again suddenly regurgitate or vomit more food. He can take only liquid and in small amounts, and even this at times induces vomiting of foul material. His trouble is made worse by the recumbent position. Epigastric discomfort is constant, but the vomiting itself is painless. The pain he has is not paroxysmal. There is no dyspnoea nor does he have palpitation. He has seen many doctors, has been in bed much, and has been X-rayed several times. Four weeks ago he had a mild diarrhoea, some clay-colored stools, and was slightly jaundiced (?).

Physical examination: A pale, anaemic-looking, only fairly nourished boy. Skin: No jaundice, though skin rather sallow. Sclera: Normal in color. Teeth and tonsils: Normal. Head: Negative. No enlarged glands nor evidence of glandular deficiency. Sexually: Mature. Heart: Negative for murmurs or increased size. Apex beat: Displaced upward but not laterally. No epigastric pulsations. Lungs: Thorax full at lower part, not normal wedge shape. Normal breath sounds not heard in lower chest, and seem altered over upper chest on right side; left side normal. Abdomen: Negative for tumors, pulsations, rigidity and tenderness. Genitals: Small right hydrocele, otherwise normal. Extremities: Normal.

Analysis of the gastric contents was not made, though stomach lavage was followed shortly by regurgitation of a small quantity of foul-smelling fluid containing some undigested food particles. The urine was practically normal. The blood examination showed a decided diminution in red corpuscles, normal number of whites, with haemoglobin seventy per cent.

Our conclusions were that we had to deal with pyloric obstruction, *i.e.*, partial gastric obstruction. The patient was radiographed by Doctors Keith and Keith, of Louisville, whose report is appended:

CONGENITAL DIAPHRAGMATIC HERNIA

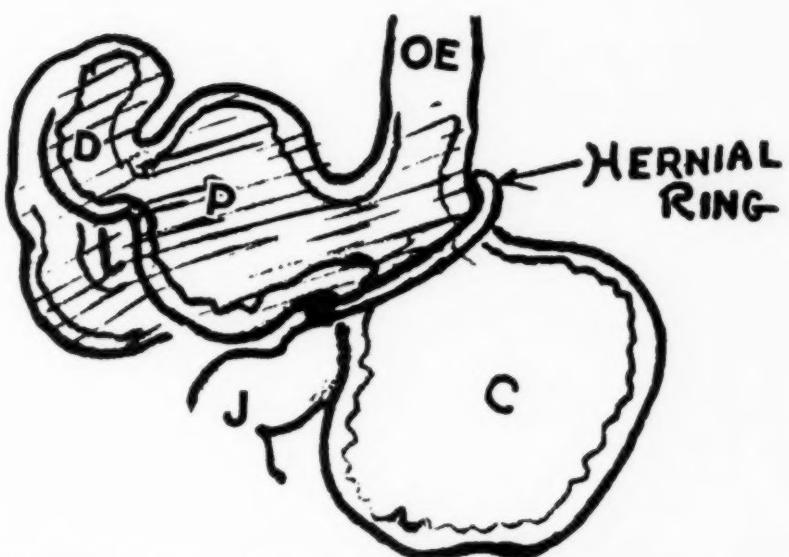


FIG. 4.—Diagrammatic drawing after abdominal exploration. Showing hernial ring with pylorus and duodenum within sac.

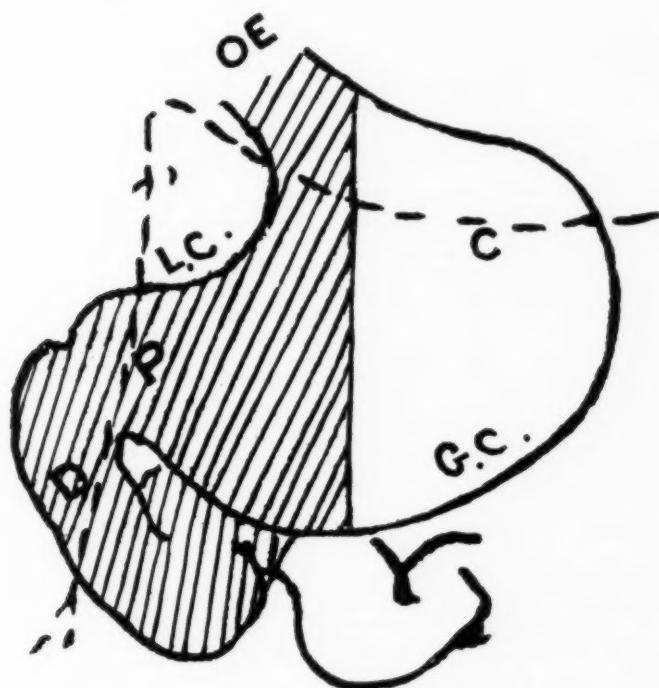


FIG. 5.—Diagrammatic drawing after reduction. Shaded portion formed hernial content.

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January 11, 1919: *Fluoroscopic Chest.*—The cardiac and aortic shadows are normal. The diaphragm is mobile, the dome being higher on the right side than normal. There is no loss of contour on either side.

*Barium Meal.*—There was a delay of barium at the cardia, with moderate dilatation of the lower end of the esophagus for about three inches. The cardia is high under the ribs on the left side, the shadow being about the size of a fetal head, with no resemblance to the stomach shadow. After waiting a few minutes a small amount of barium was seen to the right of the spine, which gradually assumed a pear shape. This shadow was entirely under the

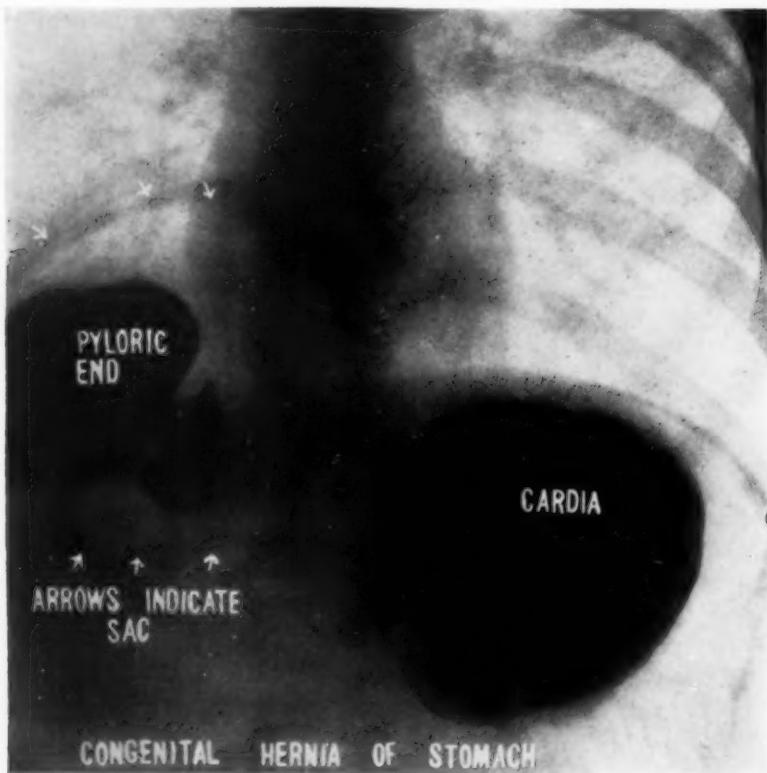


FIG. 6.—Röntgenogram immediately after ingestion of barium meal. Note duodenal cap within hernial sac.

costal cartilages and approximately on a line with the dome of the right side of the diaphragm. The shadow increased in size until about the size of a large orange, and pencil-shaped shadows could be seen connecting this mass with the mass under the ribs on the left side. Gas and fluid were seen around the shadow on the right side, and by violent percussions in the epigastrium fluctuation was elicited.

A Series of Plates show barium mass on the left side beneath the diaphragm the size of a small grapefruit. On the right side there is a much larger mass, with areas of lessened density or gas shadows completely surrounding this mass. There is no evidence of barium passing from the shadow on the right side into the small intestine.

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*Three-and-one-half-hour Meal.*—Approximately 25 per cent. of the barium had passed into the small intestine. No plates were made.

*Six-and-one-half-hour Meal.*—Approximately 25 per cent. of the meal remained in the stomach. Twenty-five per cent. in the terminal ileum. The cecum and transverse colon were partially filled, the head of the barium meal being at the descending colon.

*Twenty-four-hour Meal.*—Approximately 25 per cent. of the meal remained in the stomach. Head of the meal had progressed to the rectum, the sigmoid and descending colon being well filled. The splenic flexure was much higher than normal.

*Thirty-hour Meal.*—There was no change in the barium shadows.

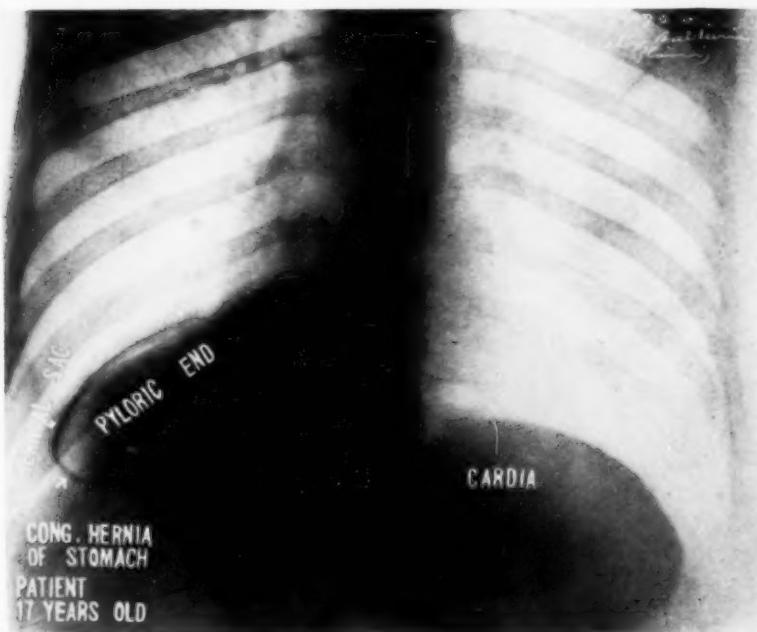


FIG. 7.—Röntgenogram with both sacs filled. Note cardiac shadow.

*Forty-eight-hour Meal.*—Approximately 25 per cent. of the barium remained in the stomach, being entirely to the left of the median line (in the cardia). No barium was seen to the right of the median line, but the fluid and gas shadows as described at first examination were easily visualized, and by vigorous palpation we could get movement in fluid and gas as fluid in chest when lung is collapsed.

*Reexamination (January 31, 1919).*—*Barium Meal.*—The egress of barium from the oesophagus was seen to appear first to the right of the median line. After the barium shadow was the size of a large grapefruit it rapidly fell below the diaphragm and to the left of the median line. Evidently at this examination the stomach was entirely in the right chest, and as soon as moderately distended with barium solution the weight of the mass pulled the stomach into the abdomen, the cardia being visualized.

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*Plates made at this time gave the same type of shadows as at former examination.*

*Diagnosis.—Hernia of the stomach into the right chest. The gas and fluid shadows we believe to be a sac for the hernia mass.*

A study of stereoscopic plates (Figs. 6, 7, and 8) made it at once clear that we had to deal with a large diaphragmatic hernia, the contents almost half filling the right chest cavity and consisting certainly of half the stomach, *viz.*, the pyloric end, with a large part of the duodenum.

On February 4, 1919, an exploratory celiotomy was performed



FIG. 8.—Röntgenogram twenty-four hours after barium meal. Air in hermetic portion of stomach gives appearance of air on the plate, and was noted as fluid in sac.

with the idea of ascertaining precisely what was the pathologic condition and if possible closing the opening by the abdominal route. When the abdomen was opened by median incision the round ligament was immediately identified and the liver found pushed well to the right; the stomach with the duodenum, a large part of the omentum, and a small portion of the liver, were herniated into the right chest cavity through an opening which would easily admit four fingers (Figs. 4 and 5). Reduction of the contents of the hernia into the abdominal cavity was attempted, and, while successful, was found to be most difficult on account of the negative chest pressure. When the viscera were released they were at once aspirated again into the hernial sac. The peritoneum was continuous into the sac, there being a distinct peritoneal covering of the

### CONGENITAL DIAPHRAGMATIC HERNIA

hernial contents. Dr. D. Y. Keith was present at the operation which was performed under nitrous oxide gas. The opening was so far posterior, in fact, being an enlargement of the œsophageal opening, it was found impossible on account of its location—not only deep and high in the cavity, but partially behind the liver—to effect closure. The abdomen was then closed in the usual manner.

On February 21 the second operation was done, the approach now being through the chest wall. Under nitrous oxide gas 5 inches



FIG. 9.—Röntgenogram taken after dismissal of patient from the hospital, about one month after operation.

of the seventh rib were excised (Figs. 10 and 11). On account of the compression of the lung some difficulty was encountered in free exposure of the hernial sac. The diaphragm was pushed upward and laterally and much thickened. Directly over the sac there was no covering except thickened connective tissue and peritoneum. No trouble was experienced from collapse of the lung, though no positive pressure was used with the nitrous oxide apparatus. We believe this was due to the collapsed condition of the lung on that side. Much trouble was encountered in replacing the contents of the hernia into the abdominal cavity, and even after this had been accomplished some difficulty was experienced in retaining the con-

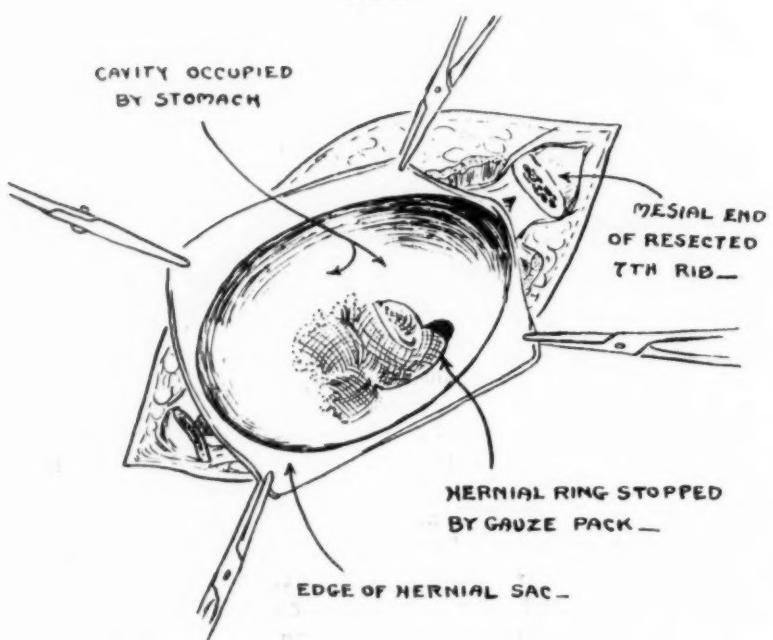
LOUIS FRANK

FIG. 10.



INCISION OVER 7TH RIB

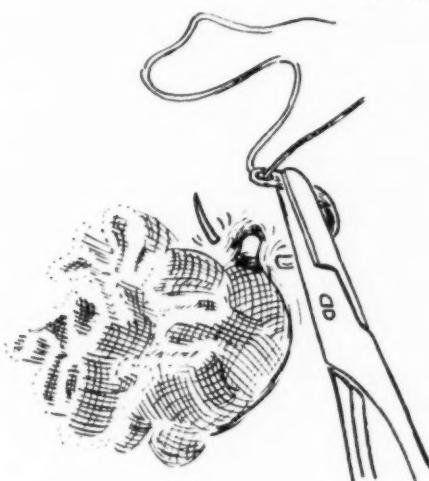
FIG. 11.



## CONGENITAL DIAPHRAGMATIC HERNIA

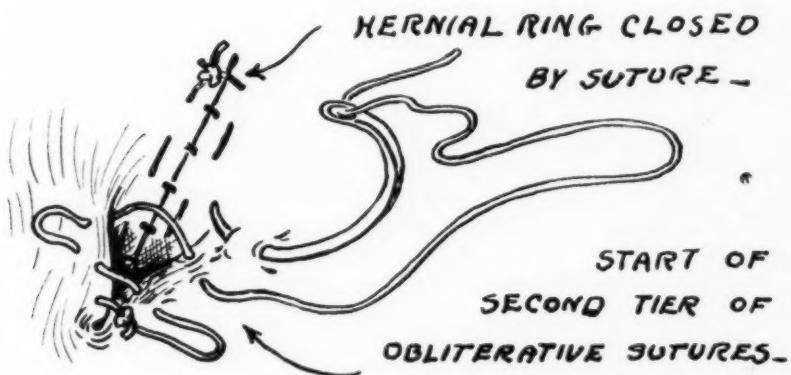
tents. The sac was not cut away, but was closed by deep through-and-through sutures extending from near the oesophagus directly across the neck of the sac. These sutures extended into the abdomen and passed from the abdomen upon the opposite side outward into the sac again. After tying these sutures the sac itself was

FIG. 12.



STARTING SUTURE OF  
HERNIAL RING -  
STOMACH RETAINED  
IN ABDOMEN BY PACK.

FIG. 13.



FIGS. 10-13.—Various steps in the operation for closure of the hernia.

obliterated by suturing with catgut (Figs. 12 and 13). The thoracic muscles and skin wound were closed in the usual manner.

Following the operation there was a rise in temperature to 102° F. and pulse to 120. These subsided to normal on the third day, following which there was no further disturbance. The patient was dismissed from the hospital on March 17, and a radiogram taken by Dr. D. Y. Keith some time after his discharge showed the stomach in normal position. The report of this fluoroscopic examination is as follows:

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There is no filling defect in the œsophagus or stomach, and many contraction waves were present. The stomach was partially filled with food before ingestion of barium. The greater curvature is two inches below the umbilicus. Cap fills normally under pressure and is very flexible. There is no irregularity on either curvature of the stomach or in the cap. There is moderate dilatation of the stomach shadow. There is no evidence of any portion of the stomach above the diaphragm. Fig. 9.

Additional literature with case reports since Scudder's paper in ANNALS OF SURGERY, vol. xv, 1912, p. 261:

- Stuart McGuire: Southern Med. J., September, 1914. One case.  
*Ibid.*: Virginia Med. S. M., December 25, 1914. One case.  
Moschcowitz: Operative Therapeusis, Johnson, 1915. Two cases.  
Miller: Am. J. Obstet., February, 1916. One case.  
Wood: Surg., Gynec. and Obstet., September, 1916. One case.  
Field: Jour. Med. Soc. New Jersey, May, 1916. One case.  
Siebert: Surg., Gynec. and Obstet., October, 1916. One case.  
Gordon: Brit. M. J., August 19, 1916. One case, congenital.  
Balfour: ANNALS OF SURGERY, January, 1916.  
Rayne-Jones: Arch. Int. Med., February, 1916. One case.  
Green: J. A. M. A., July 15, 1916. One case.  
Vitrac: J. Med., Bordeaux, August, 1916. One case.  
Mitchell: Southern M. J., July, 1917. One case.  
Bevan: Surg. Clinics, Chicago, June, 1917. One case.  
McCleave: Am. J. Dis. Children, March 2, 1917. One case.  
Mercade: Presse Med., March 22, 1917. One case, congenital.  
Martin-Du Pan: Rev. Med. La Suisse, June, 1918. One case.  
Montandon: *Ibid.*, 1918. One case.  
Schaldemose: Hospitalstid., June 26, 1918. One case.  
Hagen-Torn: Russ. Vrach, 1918.  
Downes: Surg., Gynec. and Obstet., October, 1918. One case, congenital.  
Gross: J. Med. Research, July, 1918. One case.  
Dickie: Brit. M. J., June 22, 1918. One case.  
Weidner: Kentucky Med. Journal, January 19, 1919, p. 42. One case.  
McCandless: Journal Rönt., March 19, 1919, p. 82. One case.  
Soresi: ANNALS OF SURGERY, March 19, 1919, p. 254. Three cases, one congenital.  
Berard and DUNET: Abs. Jr. A. M. A., April 19, 1919, p. 1193. One case.  
Barton: Br. Med. Jour., June 19, 1919, p. 767. One case.  
Greig: Edin. Med. Jour., June 19, 1919, p. 357. One case.  
Warren: Lancet, June 21, 1919, p. 1069. One case.  
Lake and Keim: Lancet, July 5, 1919, p. 13. One case.  
Landelius: Abs., Jr. A. M. A., July 12, 1919, p. 158. One case, congenital.  
Ware: Jr. A. M. A., July 26, 1919, p. 267. One case.  
De Courcey: ANNALS OF SURGERY, August 19, 1919, p. 179. One case.  
Bennett: Br. Med. J., August 16, 1919, p. 203. One case.  
Andrew: Br. Med. J., September 27, 1919, p. 412. One case.  
Graves (Louisville): Society report, not published. One case.  
Grewe (Cincinnati): Personal communication. One case, congenital.  
Cooper's work on Hernia, 1804, cites two adult congenital cases.

## SURGERY OF THE DUCTUS COMMUNIS CHOLEDOCHUS

By J. CHRISTOPHER O'DAY, M.D.

OR HONOLULU, HAWAII

GALL-BLADDER surgery, that is, surgery that has to do with the gall-bladder alone, is not, as a rule, difficult. Nor should it, in the absence of coexisting complications or the deprecations from previous diseases, have a death rate. The indifference shown by the gall-bladder to either an opening or a removal is, to my mind, the reason why so many arguments have been imposed in defense of opposing beliefs as to whether a cholecystotomy or a cholecystectomy should be the operation of choice. It is when we have to confront any of those alarming conditions that call for classic skill and knowledge, those accidents of disease, or the dynamics of a calculus, producing those lesions to the biliary tract that will kill unless properly dealt with, that our interest in the gall-bladder, of itself, begins to wane.

If there is a surgery more apprehensive, more trying, more full of depressing anxiety than that having to do with the repair of the bile channels exclusive of the gall-bladder and cystic duct, I have yet to encounter it. Two unmerciful oppositions impose their presence to the last, namely, inaccessibility and fragility of the structures involved. One hope, however, remains to prevent complete discouragement. Folds of peritoneum, either as strips from the gastrohepatic omentum or the great transverse mesocolon, or even the stomach itself, may be used to reinforce what otherwise might have to remain unmended. The peritoneum has the habit of throwing out exudate wherever fortification is urgent.

There are a few organs of which the surgeon is justly afraid. Such organs that will kill if disturbed too much. The pancreas is just such an one.

Ninety-five per cent. of all known pancreas (postmortems) have but one duct patent into the duodenum—the duct of Wirsung. It is then of paramount importance that the surgeon, who is likely at any time to encounter a common duct lesion, have a concise knowledge of the embryonal and mature development of both the liver and pancreas together with their respective ducts.

The pancreas has its beginning in two anlagen. The liver from one. There is a time during embryonal development when the stomach is represented by a vertical, spindle-shaped tube, and the duodenum, immediately below, by a vertical, straight one. It is at about this period of the development that the three anlagen referred to above make their appearance. One that is above and to the right is that of the liver. One to the front of the duodenum is the ventral and the one to the rear of the duodenum the dorsal anlage of the pancreas. When the anlage of the

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liver and that of the ventral pancreas bud their respective ducts, the process is so directed that the two become fused. From this fusing a third budding connects the two through a single opening into the duodenum. Following this comes the rotation, the half turn, to the right, of the duodenum, carrying with it, in the twist, the ventral anlage of the pancreas into apposition with the dorsal anlage behind, thus causing the duct from the liver to be sandwiched between. In time these two anlagen are fused into the pancreas proper. The duct that meantime had developed within the dorsal anlage grows into that of the ventral anlage, and in five per cent. of the known cases (Opie) becomes patent through an independent opening into the duodenum somewhere above the conjoined opening of the hepatic and the duct of Wirsung. The duct of the dorsal anlage becomes the duct of Santorini. That ninety-five per cent. of the known pancreas have but the one duct patent into the duodenum, the duct of Wirsung, the first cause of pancreatitis is immediately apparent. Choke the ampule of Vater with either a calculus or a conglomerate of inflammatory débris, and unless the higher, or duct of Santorini, is patent pancreatitis, with all the dangers such an inflammation entails, will likely ensue.

From that portion of the upper margin of the pancreas where the common bile duct pierces the gland, down to where it joins the duct of Wirsung in the formation of the ampule of Vater, the surrounding glandular tissue so reinforces it that distention can only take place with difficulty. A biliary calculus, then, that is small enough to traverse this portion of the common bile duct is, as a rule, small enough to escape through the papilla of Vater.

Above the margin of the pancreas, however, it is different. Here a stone the size of a robin's egg may be forced along the duct until the pancreatic margin is reached, where unable to go further it may by pressure necrosis destroy the duct, and permit the stone and bile to enter the lesser peritoneal cavity. Unless such an accident is promptly dealt with, the bile soon reaches the general peritoneal cavity through the foramen of Winslow, where it will likely cause death by cholæmia.

In my own case of this character inflammatory action had sealed the foramen of Winslow. The stomach was pushed well forward by the accumulated bile beneath. This case was dealt with by implanting the stump of the duct directly into the stomach.

In his instructive treatise, "The Repair and Reconstruction of the Hepatic and Common Bile Ducts" (*Surgery, Gynaecology and Obstetrics*, January, 1918), Professor Ellsworth Eliot, Jr., of New York, very kindly included the report of this case. The following is his condensed abstract of it:

CASE IV.—(Reported by O'Day.) Patient gave a history of repeated attacks of colic, the jaundice subsequently becoming persistent. On operation a fistulous tract was found leading from the perforated duct to the lesser peritoneal cavity which was

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shut off from the greater cavity by obliteration of the foramen of Winslow. In the lesser cavity was found a considerable amount of bile containing one calculus. During an attempt to free the choledochus it broke off at a point just above the adherent mass in which the termination of the duct was embedded and abundant bile exuded from the

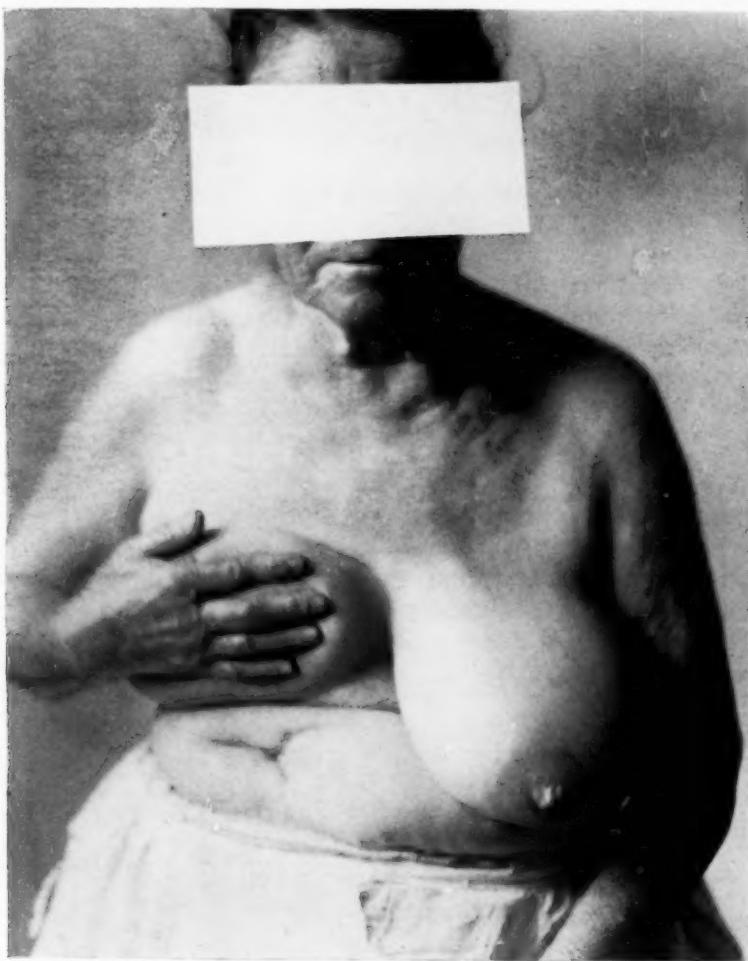


FIG. 1.—Showing condition of patient eleven years after choledochogastrostomy for ruptured ductus choledochus.

proximal end. An anastomosis was done between this stump and the anterior wall of the stomach in its lower one-third. The gall-bladder was obliterated and was not disturbed.

*Recovery.*—Six years after the patient was in excellent condition without indication of any disturbance of digestion. The accompanying photograph (Fig. 1) is the same patient eleven years after the operation. She has gained more than forty pounds in weight and has enjoyed every meal since.

Experiments together with case observations have brought us to the belief that jaundice of itself is not capable of causing alarming hemorrhage. But where both the

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liver and pancreas are obstructed control of the bleeding during operative interference may be most difficult. In our experiments it was found that pancreatin added to fresh blood prevented clotting.

A case in point may be mentioned. Mrs. S., aged forty-two years, married, mother of four children. From the birth of her youngest child, then seven years, she dates the onset of her "stomach trouble." Periodical attacks of epigastric pain and a depression that seemed entirely out of proportion with the degree of the pain's severity. Before the attack would get well under way she would experience chilly sensations, and once the pain reached the height of its severity nausea would precede a profuse cold sweating. These attacks came and went at regular intervals until the last one which, owing to its character, was mistaken for an acute perforative gastric ulcer. Upon making our incision into the upper abdomen we were immediately confronted with a most alarming hemorrhage. Every point of the incised area bled freely. Nothing seemed capable of stopping it. With great difficulty we succeeded in getting to the stomach. It was normal. Our sponges continued to become saturated with blood, the patient's condition became critical, and while we closed the wound with frequently repeated through-and-through interrupted sutures, the oozing continued from between with alarming aspect. Death occurred within six hours and postmortem showed a large pancreatic calculus lodged at the junction of the duct of Wirsung and Santorini. Back of the stone the pancreas was completely obstructed. Its tissue was soft and swollen. The fibrous degeneration noted by Opie in his cases of pancreatic calculi was not present. There had been no glycosuria.

With the common bile duct completely severed at some point between the junction of the cystic duct and the upper margin of the pancreas, the danger may be obviated by the performance of cholecystenterostomy. But when this, for any reason, is impossible, a much more difficult problem is presented. In the face of such a problem the surgeon must remind himself as to whether or no he has, in his anxiety, taken anything for granted. The flood of bile encountered under these trying circumstances is so likely to convey the notion that the bile duct must be completely severed that, unthinkingly, he, himself, may, unless the truth is fully ascertained, complete what in reality is but a partial dissolution of continuity, and in so doing deprive his patient of the safest and surest means of a recovery, for while the slightest strip remains to connect the proximal and distal ends, the otherwise severed duct, with the application of proper drainage, is capable of restoring itself to complete functional continuity. What is proper drainage in such an emergency? It is the drainage that one establishes through a previously adjusted cofferdam. How is such a cofferdam best installed? Long, narrow strips of gauze are carried from the upper angle of the wound through an opening made in the gastrohepatic ligament, and their lower ends made to plicate around

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the large rubber drainage tube previously carried down to the point of leakage. The way out the strips are stockaded around the tube, and the wound from just below this stockade to the lower angle closed with tight through-and-through silkworm-gut sutures. Strips of peritoneum from wherever they may be secured best (I have found from either the gastro-hepatic omentum or the transverse mesocolon) should be, with as much of their blood supply as possible, made to parallel the duct, for these strips will pour out exudate just where it is needed, and in this hasten what otherwise might prove to be a painfully slow regeneration.

When complete separation of the duct has actually occurred, and when, for any previous accident to the gall-bladder, cholecystenterostomy is out of the reckoning, how, then, is a biliary tract to be reestablished? Several methods are available.

With my own case, the one referred to by Professor Eliot, when it was encountered, implantation of the duct's stump into the stomach seemed the best and safest way out. The pouring of the bile into the stomach directly from the common duct, we reasoned, could do no less than make a gastro-jejunostomy admixture; nor did it, as subsequent events have shown, yet it fails to appeal as a procedure of choice.

A. E. Rockey divided the lower portion of the stomach, implanted the bile duct into the severed distal end, sutured the proximal end blind and completed the work by a posterior, no-loop gastro-jejunostomy. In another case the jejunum was divided a few inches below the duodeno-jejunal junction. The distal jejunum was carried up to receive the stump of the bile duct, passing in its ascent to the rear of the stomach through an opening in the transverse mesocolon. In this case the work was completed by an end-to-side jejuno-jejunostomy.

Any one of these methods is capable of restoring the function of the structures implicated, and the choice must, of necessity, rest with a clear vision of the existing condition of the interdepending parts. Stone in the ampoule of Vater can only betray its presence by obstructing. Such an obstruction becomes obvious when the proper examination of the biliary tract is made. To aid in this examination it should be remembered that such an obstruction causes the ducts, including the gall-bladder, to stand out full and tense. It is when this fullness of the common duct can be traced to the margin of the pancreas that obstruction within the ampule is betrayed. One cannot always be sure of the finger's excursion through the foramen of Winslow. True, a distended duct may be recognized, but nothing short of palpation from pancreatic margin to liver and gall-bladder is sufficient. It is my experience that such an examination is best made by drawing the stomach and transverse colon well forward and then through a rent made in the transverse mesocolon insert the examining hand into the lesser peritoneal cavity. When finally the duodenum has been opened, the papilla will be seen to pout, and this is

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good, for it tends to make easy the dilatation necessary for the delivery of the offending mass. In our hands, the small alligator-forceps is the ideal instrument for such dilatation and delivery.

A case that had been examined by Dr. W. B. Holden as well as myself, and reported later before the City and County Medical Society of Portland, operation was considered too risky because of a coexisting and rather severe glycosuria. The blood, however, bore little or no alarming sugar content, and upon this we modified our reluctance to operate. After a painstaking preparation the upper abdomen was opened. The gall-bladder as well as the entire biliary tract was found conspicuously distended. The pancreas, too, was markedly swollen. The papilla of Vater pouted prominently, and five small black biliary calculi actually shot out the moment we spread the opening with the small alligator forceps. The five stones had been conglomerated into one mass. A gush of bile followed. The reason we did not commit the common error of opening the gall-bladder first, was our inability to find the obstruction proximal to the upper margin of the pancreas. Compressing the gall-bladder while an examining finger rested on the common duct just above its dive into the head of the gland would cause a further bulging of the already distended tube. No jaundice or hemorrhage having occurred throughout the entire history of the case brought us to the conclusion that the duct of Santorini must have been inadequately patent into the duodenum. After we had closed the duodenum and turning our attention once more to the gall-bladder, it was found to be in a state of collapse. We now had the explanation of the gush of bile which had followed the conglomerated stones. Full recovery with never a return of the glycosuria was the reward.

It is a grievous mistake to open a distended gall-bladder before the exact point of the obstruction has been determined, for the moment it is done the hapless surgeon has forced himself to grope within a darkness of his own making.

## A PERMANENT COLOSTOMY OR ENTEROSTOMY WHICH MAY BE CLOSED BY AN EXTRAPERITONEAL OPERATION

BY ROBERT C. COFFEY, M.D.  
OF PORTLAND, OREGON

In modern intestinal surgery colostomy or enterostomy has a wide degree of application. There are many instances in which we now open the bowel to temporarily divert the fecal current from a pathological field or from a field of operation. Enterostomy or colostomy performed for this purpose may be required to functionate for months or years and should completely divert the fecal current. Colostomy of the Mikulicz type has usually been performed for intestinal growths where it was preferable to have the bowel draw in and help to close itself as rapidly as possible, after its work was performed. When an enterostomy or colostomy has been performed for the relief of pathology lower down, or for the purpose of protecting a surgical field lower down, it is necessary for the opening to functionate until the pathological lesion or surgical field has been restored to normal. This sometimes requires a long time. When the loops of an intestine have been sewed together and brought out through the abdominal wall in preparation for doing a Mikulicz closure later, there is a constant tendency for the loop to draw back into the abdominal cavity and effect a premature closure, thus defeating the purpose of the operation. On the other hand, the form of permanent colostomy described by Sistrunk, Warbasse, and others, in which a section of the abdominal wall is brought together under the loop, precludes any form of extraperitoneal closure. The following technic combines the features of a temporary and a permanent colostomy. A loop of bowel is drawn up through a longitudinal wound in the rectus muscle. This incision should be from two to three inches in length. The mesenteric borders of the two limbs of the intestine are sewed together, leaving some space at the apex of the loop. Two or three interrupted purse-string sutures close the mesentery back of this line in order to prevent a knuckle of intestine from becoming incarcerated in the space. Another line of sutures brings the free margins of the intestine together, thereby bringing two flat surfaces of the two limbs together. The loop of bowel is now sutured to the edges of the parietal peritoneum by a continuous lock-stitch of chromic catgut. A similar suture fastens the loop to the aponeurosis and muscle. A tongue-shaped flap of skin, one-half inch wide at the apex and about two inches long, is dissected from one side of the wound. A pair of artery forceps is thrust through the mesenteric space at the apex of the loop and the space is dilated. Through this space the strip of skin is drawn and sutured to the skin on the opposite side. After the skin wound has been closed with interrupted chromic

FIG. 2.

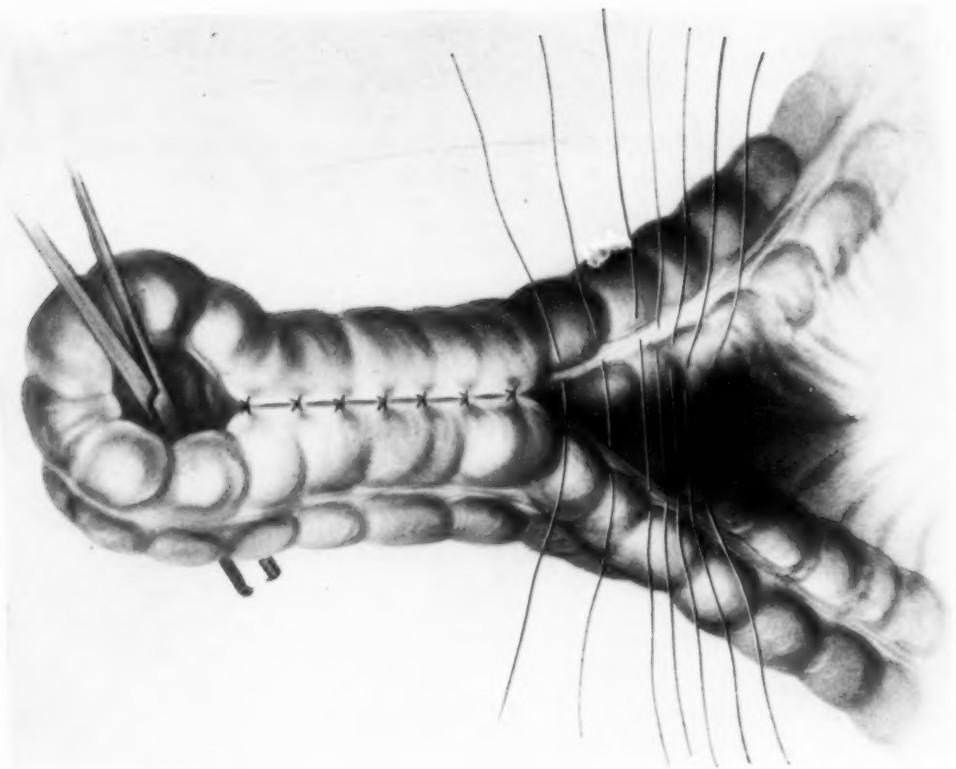


FIG. 1.

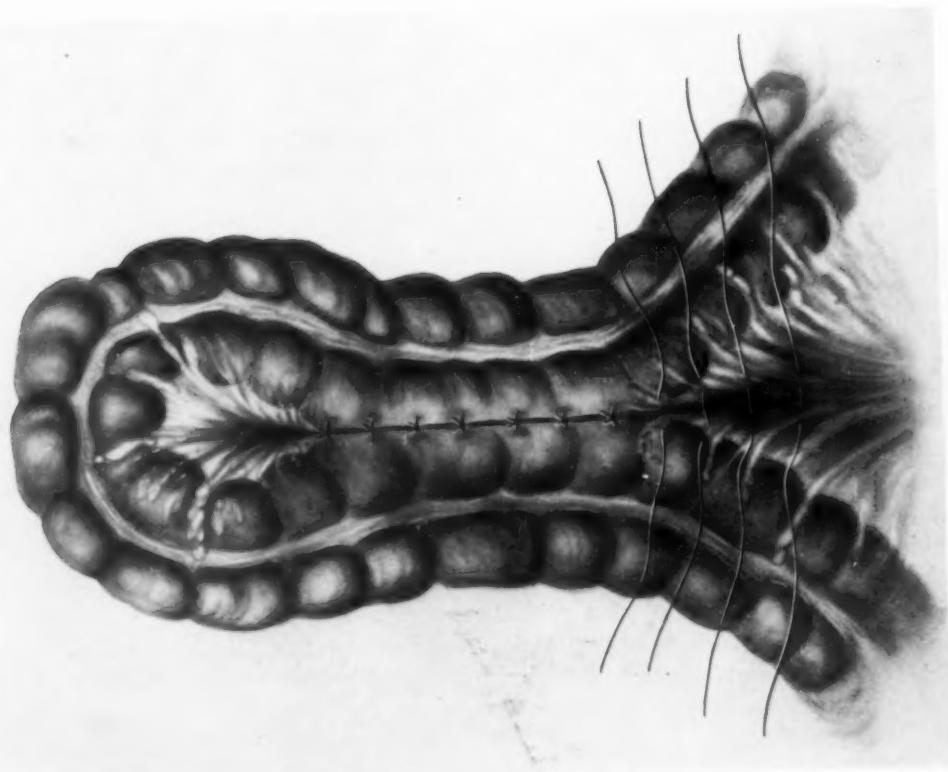


FIG. 3.

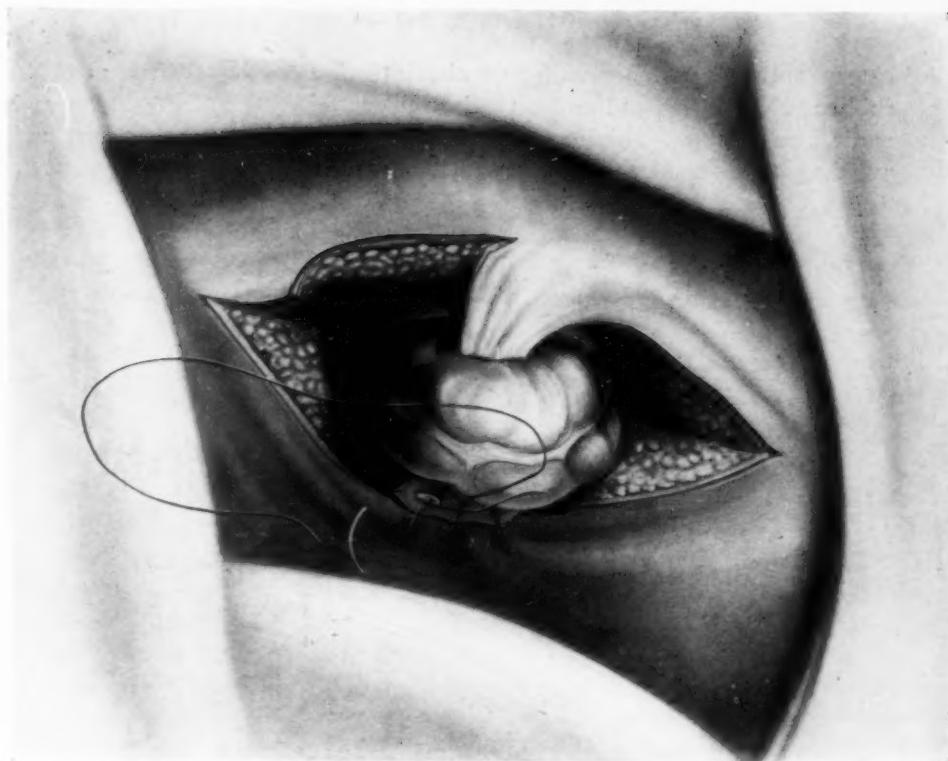
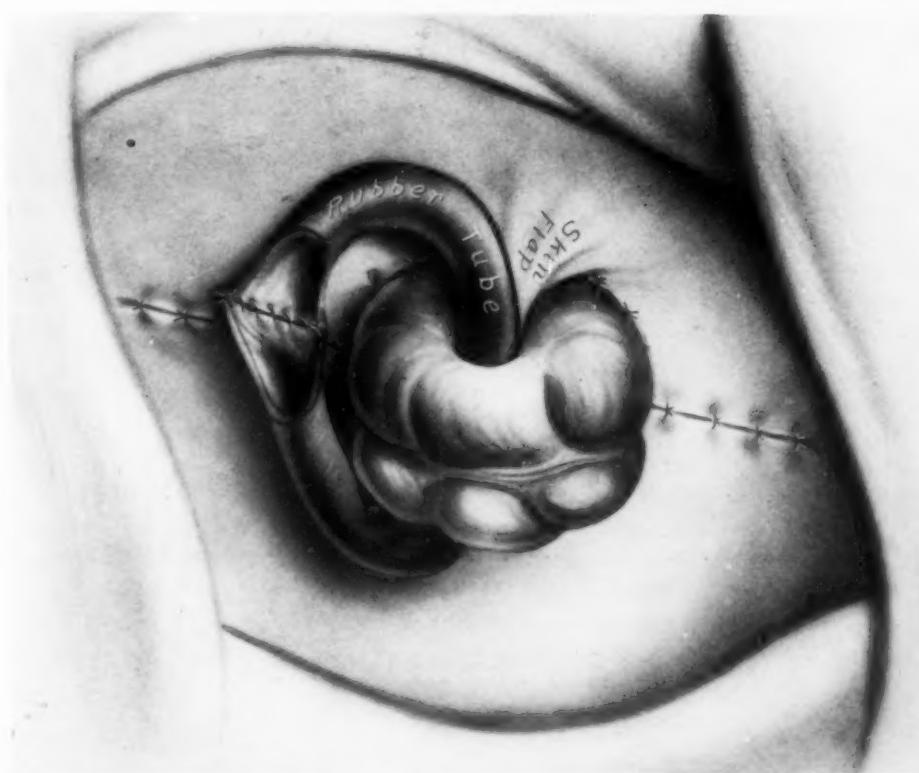


FIG. 4.



catgut sutures, which also fasten the intestine to the skin, a piece of rubber tubing is passed under the bowel on top of the strip of skin and made into a ring. This is for the purpose of carrying the weight and avoiding tension on the skin flap. The intestine is opened when it is

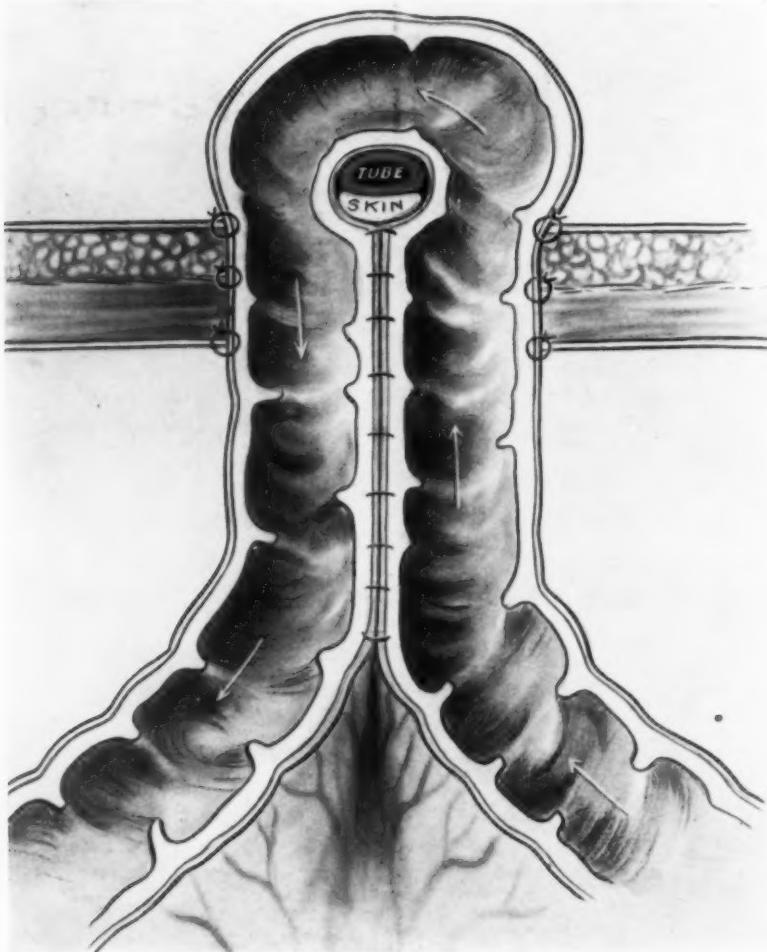


FIG. 5.

desired, completing the colostomy. When it becomes desirable to close the colostomy opening, the septum, including the skin flap under the loop, may be destroyed by pressure clamps.

The opening then becomes a fecal fistula, and may be closed by the extraperitoneal method described by me in the ANNALS OF SURGERY, June, 1907—also reproduced in the latest editions of Moynihan's "Abdominal Operations."

## GASTRO-ENTEROSTOMY STILL THE TREATMENT FOR CHRONIC GASTRIC AND DUODENAL ULCER

BY ROBERT C. COFFEY, M.D.  
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IN discussing the advisability of a surgical procedure for a given pathological condition, we have to consider several points:

1. Immediate danger resulting from the operation itself;
2. Subsequent dangers more or less intimately associated with the results of the operation;
3. Amount of final relief of morbidity;
4. Life expectancy of patient following the operation for a given condition.

This last topic has recently been discussed by Balfour in the November ANNALS OF SURGERY in connection with the study of gastric-duodenal ulcer. This is certainly going to open up one of the most interesting phases of the subject of our paper, but is one which can only be discussed knowingly after many more years have elapsed. However, Balfour's paper constitutes one of the most interesting contributions to this subject which has been presented for a long time. In our study of this subject I shall confine myself very largely to my own work, and shall include in this study every case of chronic gastric or duodenal ulcer which has been operated on in my regular operating hospital. This report does not include approximately twelve operations done outside of my regular operating hospital for the reason that I have had no opportunity to keep a record of these cases. Of these outside cases not reported here, one died as the result of faulty technic. I was holding a clinic in a distant city, demonstrating the "no-clamp" operation. The operating room was strange, and all assistants and instruments were unfamiliar to me. In addition to this, I was talking and operating at the same time. The surgeon whose case I was operating on spared me the painful news. After some months, I wrote him point blank, asking for the condition of the patient. He stated that the patient died from hemorrhage a few hours after the operation. Undoubtedly, in my effort at demonstrating, combined with strange surroundings, I overlooked a blood-vessel at the time of the operation.

Discussing statistics, we must remember that they are only of relative value, no matter how accurate or how long a period or how extensive the individual's practice. Therefore, statistics which include less than five or ten years of a man's practice, I would consider of very little value. Statistics which include a single year's work of a surgeon's professional lifetime are of no value at all taken alone. Statistics in which a man reports a hundred consecutive cases of major operations performed with-

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out a death are far worse than valueless, as a rule, because, in the first place, the motive for presenting such a series of statistics is not scientific, but egotistic. We would all like to report such statistics, but when we consider the seriousness of scientific facts dealing with human life, they must be thrown out of consideration entirely.

My first gastro-enterostomy for duodenal ulcer was performed April 14, 1904; the last October —, 1919, but before I had performed a gastro-enterostomy for ulcer, I had done several hundred experimental anastomoses on animals, and had also mastered the through-and-through suture as taught by Connell, so that technically I was quite well prepared to do an anastomosis.

The total number of cases of gastro-duodenal ulcer treated by operation from April 14, 1904, to October —, 1919, was 233; the deaths from operation were 10—4.33 per cent.

In Balfour's paper, published in the November, 1919, *ANNALS OF SURGERY*, 2431 cases are reported as having been operated on in the Mayo Clinic between 1906 and 1915. Of these, 545 were gastric ulcers with 4.5 per cent. mortality, which amounts to about 24 deaths. One thousand six hundred and eighty-four were duodenal ulcers, with 2 per cent. mortality, or about 34 deaths. When thrown together and averaged, the total mortality of the Mayo Clinic for nine years, from 1906 to 1915, including 2431 cases of gastro-duodenal ulcers, is 58 deaths, or a mortality of 2.38 per cent.

The Massachusetts General Hospital reports for the four years—1911-1912-1913-1914—show 164 cases of chronic gastric and duodenal ulcers treated by operation with 11 deaths, or 6.7 per cent.

Peck reports the work of the staff of the Roosevelt Hospital, including a number of surgeons, which shows that from January, 1910, to June, 1915—five and a half years—104 cases of chronic ulcer were operated upon, with 10 deaths, or 9.6 per cent.

Finney reports 200 cases treated in the thirteen years from 1902 to 1915, with 12 deaths, or 6 per cent.

Eiselsberg reports ten years' work, from 1904 to 1914. In this, he reports 460 cases of gastric and duodenal ulcers treated by operation. Of these, 38 died, or 8.3 per cent. It is further noted in his paper that there were 41 pylorectomies in which the death-rate was not stated. This, undoubtedly, would have still further raised his death percentage.

It is very important to study the cause of death in this series. In my 233 operations for gastric and duodenal ulcer, the first case of death was No. 20 of this series, December 6, 1907. This was an old man, more than sixty years of age. The operation lasted more than two hours, although only a simple gastro-enterostomy was performed. He never passed any urine after the operation was performed; died in convulsions three days after the operation.

The second death was in case No. 43 of this series. He died October 28, 1910. The patient was a healthy man about fifty years

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of age, with an obstructing ulcer at the pylorus, making an ideal case for permanent cure. Thirty hours after the operation the patient, who had been perfectly normal up to that time, began to show an increasing pulse rate without nausea, and without passage of blood from the bowels. He gradually grew weaker, and died twenty-four hours from the time symptoms began. Postmortem revealed the fact that the anastomosis was in perfect condition—evidently no hemorrhage at this point. Careful search revealed a slit about  $1\frac{1}{2}$  inches in length in the mucous membrane, located about an inch from the anastomosis; running across this slit was a large open blood-vessel. The slit had been made by the pressure of the clamps, and the large vessel had been devitalized and exposed thereby. The stomach being in good condition, the hyperacidity marked, the wall of the devitalized exposed vessel had apparently been digested at this stage, and the hemorrhage began. Incidentally, I think I may state that it is probable that most cases of hemorrhage coming on from twenty-four to sixty hours after a gastro-enterostomy are due to this cause. Hemorrhage coming from the line of union should appear much earlier than this. Therefore, although clamps are of great service in the technic of an operation, it must not be forgotten that they offer a very definite danger.

Our third death occurred in case No. 63, December 12, 1912. This followed a Rodman pylorectomy and gastro-enterostomy performed at the same time. This patient died of pneumonia, but was otherwise a very healthy man.

In the early stages of stomach surgery, pneumonia was the great danger. The dictum of Mayo and others, recommending the upright position for these patients, greatly lessened this danger. In our experience, we have learned to use about 3 grains of camphor in oil every three hours for the first twenty-four hours after stomach operation.

The fourth death occurred in case No. 71, May 29, 1913. This followed an Eiselsberg exclusion operation with posterior gastro-enterostomy. Patient died with persistent vomiting of bile and acute dilatation of the stomach. A postmortem was not held, but I am sure that death was due to too much tension at the point of anastomosis; it sharply angulated the intestine.

Our fifth death occurred in case No. 98, July 30, 1914, and followed an extensive sleeve resection for an ulcer along the lesser curvature. This patient died from shock within a few hours after the operation.

Our sixth death was in case No. 108, January 6, 1915. The operation was an Eiselsberg exclusion, with posterior gastro-enterostomy. Patient died of regurgitation of bile and dilatation of the stomach, undoubtedly due to too much tension on the anastomosis by the stomach.

Our seventh death was No. 120 of this series, July 9, 1915. About one-third of the stomach was removed, with the idea that it was probably malignant. The patient recovered from the operation as far as shock was concerned. On the second day, he began to

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vomit bile, and any food which was put into his stomach. This kept up until on the eleventh day, a second operation was attempted, when it was found that a very short stub of stomach, passing through a rather short, fat mesentery, had made such a drag on the point of anastomosis as to funnel the mesentery and sharply angulate the intestine below the anastomosis.

The eighth death occurred in case No. 137, March 7, 1916. In this operation a Finney pyloroplasty combined with a Balfour cautery operation for an ulcer on the lesser curvature was performed. Patient practically passed no urine from the time of the operation to his death, two days later.

The ninth death occurred in case No. 182, October 18, 1917, as the result of hemorrhage coming on six days after operation. Hemorrhage came on very suddenly, and was repeated two days later with the result of death. Unfortunately, I was so engaged at the time that I could not have a postmortem performed, but this patient had an acute cold at the time of the operation; had a severe cough from the time of the operation until the hemorrhage took place, and probably had an acute ulcer developed at the site of operation, or had a broken mucous membrane, due to clamp pressure.

Patient No. 180 died a month after leaving the hospital of empyema. This patient had a cold when he was operated upon, had a severe cough all the time he was in the hospital, which was no doubt followed by empyema after he left the hospital, producing his death.

We had two other stomach patients, Nos. 183 and 184, in the same ward, who had very close calls as the result of infective colds developing in this ward. Incidentally, we may state that operation on a patient with even a slight cold is a very serious matter and should never be done.

The eleventh death followed an operation for duodenal ulcer which had developed in a patient who had had incomplete rotation of the gastro-intestinal tract. The duodenum went directly downwards on the right side of the spinal column, external to the ascending colon, and below the caecum exactly in the same manner as noted in the arrangement of a dog's gastro-intestinal tract. The ulcer was large, quite acute, located well down the duodenum, near the bile duct, thus making excision or a Finney pyloroplasty impracticable; the duodenum running directly downwards from the bile duct was not very movable. There was no way by which the loop of intestine could be brought up for an ordinary type of posterior gastro-enterostomy except by a very long loop which must necessarily originate down near the caecum. Therefore, an opening was made into the lesser peritoneal cavity back of and below the pyloric end of the stomach. This end of the stomach was drawn out through this opening for the duodenum, which had a very short mesentery. An anastomosis was made then between the stomach and the duodenum, about 2 inches below the ulcer. A good deal of tension was left, but it was thought that it would work.

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The tension, however, seemed to be so great that it did not work, and on the fourth day after operation, the abdomen was again opened and a sharp kinking was noticed at the anastomosis, brought about by the pulling backwards of the stomach. Separating this and producing a better condition than the one before was quite an extensive ordeal and proved to be too much for the patient, who died a few hours after the second operation.

Another death occurred about this same date, but this case obviously has no connection with the operative mortality for duodenal ulcer, as will be shown by the following report. The patient came in having had apparently a total obstruction for several days, almost a total obstruction for a much longer time. The stomach contained large quantities of foul matter; patient was brought in for the purpose of emptying and cleansing patient's stomach for a day or two before any operation was attempted. When the nurse first introduced the stomach tube, the patient became strangled and began to cough violently. Soon he began to cough frothy blood, and went into quite rapid collapse, due partially to the hemorrhage and partially to the dyspnoea. A little later examination showed complete consolidation over the left pleura: no breath sounds on the left side. It was evident that the lung had been ruptured by the coughing. Patient remained in a doubtful condition for seven days. With a collapsed lung and no food whatever going through the pylorus, his condition became desperate. It was obviously necessary to get a quick opening from the stomach to the intestine, so under local anaesthesia the abdomen was opened and a quick gastro-enterostomy performed, with hope of getting immediate relief. This case, of course, became an emergency operation, and could not properly be included in operative results for chronic gastro-duodenal ulcer. It is mentioned here, however, because the case was referred for operation as a chronic duodenal case, and this report makes the record straight.

The most important thing about the second point of our discussion, namely, *remote post-operative complication*, is the formation of secondary ulcers. We have had secondary or recurring ulcers in the following cases:

No. 44, following an excision of an ulcer located on the posterior wall, near the lesser curvature of the stomach. The lesser peritoneal cavity was opened and packed with gauze, stomach turned up and the ulcer excised from behind. The patient did fairly well for a few months, but soon began to develop her old symptoms. She came in for examination about three years later. The X-ray showed a definite hour-glass contraction. The ulcer has recurred and the patient is probably no better than if no operation had been done.

The next recurrence was in patient No. 69 of this series. The ulcer was excised and the patient made a good recovery, but later has returned.

The third case, No. 72, an Eiselsberg exclusion and gastro-

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enterostomy, was performed for duodenal ulcer July 22, 1913. Patient did fairly well for a few weeks, but on January 23, 1914, six months after the operation, patient returned, and the ulcer had recurred. It was found in the stomach, distal to the anastomosis; was about two inches in diameter. The ulcer was excised and the opening closed. A year later the patient came back in a very weakened condition. The ulcer had recurred in practically the same place. Operation was again attempted, which resulted in the death of the patient.

The fourth recurring ulcer was in case No. 83 of this series. First operation was performed January 5, 1914. The patient was a doctor; had had a previous exploratory operation for supposed duodenal ulcer. The previous surgeon had found a lot of adhesions in the neighborhood of the duodenum, but had failed to locate an ulcer, and had closed without doing anything further. On January 5, 1914, we did an Eiselsberg exclusion with posterior gastro-enterostomy. The patient was not as well after the operation as he should have been. A few months later he returned with certain symptoms of a recurrence. We opened the abdomen, found an ulcer about 2 inches in diameter in the stomach distal to the anastomosis. The ulcer, however, involved the anastomosis in this case. The anastomosis was cut off, ulcer removed, stomach closed, and intestine closed. Then a long loop anterior gastro-enterostomy was performed. In a short time the patient began to have trouble again. We did not look upon further operation favorably, and he was not getting satisfactory relief, so he went to Rochester. On the way there his secondary ulcer apparently perforated. He was in a very serious condition. In talking to Doctor Mayo, he was of the impression that a simple gastro-enterostomy had been done. Doctor Mayo opened him to relieve the acute perforation. The perforation had occurred well up on the left side. Anastomosis was cut off, and stomach and intestines closed. Twenty-four hours afterwards, the patient showed no evidence of bile or other secretions in the stomach, and was not doing well. Doctor Mayo wired me, asking what operation I had performed. I told him that I had done an Eiselsberg exclusion operation. He immediately took the patient to the operating room, and under local anaesthesia, drew the severed and closed ends of the stomach and duodenum together, and made an anastomosis. The patient made a good recovery, but soon began to show symptoms again, so three months later he went back to Rochester, when it was found that another ulcer had formed where the last anastomosis had been made. This ulcer was removed and a plastic operation was done. He did well for nearly three years after this, when suddenly he had a very severe hemorrhage, continuing for some days, which it seemed would produce a fatality. He gradually recovered from the hemorrhage, but was in a very desperate condition; was brought to me with a very extensive hernia from his numerous operations. The skin had become so thin that the intestines almost came through. Owing to the numerous scars, it was not thought

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wise to open immediately over the stomach, so an incision was made in the healthy skin diagonally across the lower margin of the ribs and ensiform cartilage and the flap thrown downward till the stomach could be reached. Neighborhood of the stomach was surprisingly free from adhesions. The finger, passed down towards the pylorus on the outside of the stomach, indicated a hard ring around the outlet. An anterior gastro-enterostomy seemed to be the only hope of doing anything. A loop of the jejunum was brought up and sewed to the anterior surface of the stomach. The stomach was opened. A finger was passed downwards to the outlet, which was practically closed, and at which point another ulcer had developed. The anterior gastro-enterostomy was completed, and the patient has done very well ever since. His last operation was performed about five months ago. It is difficult to tell what the future has in store for this patient.

The fifth case of secondary ulcer was operated on December 23, 1915, No. 134 of this series. Ten months after this operation the patient returned, having had severe symptoms for several months, and alarming symptoms for the previous few days. Patient was opened; secondary jejunal ulcer had perforated. The anastomosis was cut off, but the patient died with suppression of urine within forty-eight hours.

The sixth recurring ulcer occurred in case No. 144 of this series. An hour-glass stomach, based upon an extensive old ulcer of the lesser curvature, also a duodenal ulcer, with a large indurated mass around it. The middle of the stomach was resected, and end-to-end anastomosis made along with a gastro-enterostomy distal to anastomosis. Patient did well for a couple of weeks, then began to show stomach symptoms. This was not very severe, so the patient got up and was around in very good condition. On the thirtieth day after operation, after taking a full breakfast, patient developed an alarming hemorrhage from the stomach, and died within thirty minutes. I was called and immediately did a postmortem, and found that a secondary ulcer about 2 inches in diameter had formed along the line of the circular anastomosis. Digestion apparently had corroded a large vessel which was standing wide open in the wound. The induration around the pyloric ulcer had practically disappeared.

The seventh patient to develop secondary ulcer was No. 148 of this series. Operation was performed November 18, 1916. The ulcer was along the lesser curvature. Pylorus was wide open, so the Balfour cautery was used. April 20, 1917, the patient returned with the same symptoms. The ulcer had reformed and was much worse than when it had been cauterized before. At this time it was excised and a posterior gastro-enterostomy performed.

The eighth case was a patient who had been operated on. He came back complaining of severe diarrhoea. Immediately after eating any food his undigested food began to pass out through the rectum almost immediately after eating. After two weeks' observation the abdomen was opened; a large inflammatory mass was found, in-

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volving the transverse colon and jejunum distal to the anastomosis. On further investigation, it was found that an opening existed between the jejunum and the colon, about  $\frac{5}{8}$  inch in diameter. A jejunal ulcer had formed distal to the anastomosis; adhesions to the transverse colon had taken place, and an opening between the two intestines had been automatically established. The two intestines were severed, the openings closed, a large fold of omentum interposed between the two intestines and the abdomen closed.

In addition to these, a few of our cases have had severe hemorrhages several months or a year after operation, as will be seen by the tables. Whether these have been due to new ulcers or to the bleeding of the old ulcers, we are not able to determine. These cases have been without pain and usually have had but one or two severe hemorrhages.

Case 9, No. 132 of this series, operated on December 2, 1915, hour-glass contraction based upon a large ulcer of the lesser curvature, severe resection.

It will thus be seen that of the 233 cases operated for ulcer, 9 have had definitely demonstrated secondary or recurring ulcers. Of these only two were following simple posterior gastro-enterostomy. About 3.8 per cent. of the ulcers have recurred either at the point of excision or a new place. There are probably others which had not given so much trouble.

Of the 8 sleeve resections, two, or 25 per cent., have had recurrence of the ulcer. Two have had recurrence of the ulcer in the line of suture. Of the 11 cases of excision of the ulcer, either with the knife or Balfour cautery, without gastro-enterostomy, 3 have developed a recurrence of the ulcer. Out of 22 Eiselsberg exclusion operations, 2 have developed secondary ulcers, and these have recurred repeatedly after removal (3, 9 per cent.). While out of 165 simple gastro-enterostomies, only 2 have been known to develop secondary ulcers, about 1.2 per cent.

Of the 3 cases having severe hemorrhage at a remote period following operation, only one occurred in the 165 simple gastro-enterostomies—a little more than  $\frac{1}{2}$  of 1 per cent., while 2 of the 22 Eiselsberg operations, or 9 per cent., in addition to the two definitely proved ulcers in this group, developed severe hemorrhage.

Now, what about the expectancy of life, as regards cancer, following ulcer treated by these various operations? Of the 233 cases thus operated upon for ulcer of the stomach and duodenum, 4 have been known to have developed cancer.

The first case we can report as having died of cancer, No. 51 of this series, was operated upon May 10, 1911, for what appeared to be a duodenal ulcer located at the pylorus. A posterior gastro-enterostomy was performed. The patient died of carcinoma of the stomach in 1915, four years after the operation.

The next case, who was believed to have died of cancer, was No. 74, operated upon August 4, 1913. An Eiselsberg exclusion opera-

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tion was performed. The patient died two years later with stomach trouble and anaemia; it was thought by the family physician to be cancer. However, this may also have been a secondary ulcer.

The third, No. 81 in the series, operated upon December 29, 1913, for what appeared to be an extensive indurated ulcer. A Rodman pylorectomy was performed. Patient died of cancer of the liver a little more than a year later.

The fourth case to die of cancer, No. 143 of this series, was operated upon September 11, 1916, for an extensive saddle ulcer, 4 inches in one direction, and  $4\frac{1}{2}$  inches in the other. The ulcer in no way resembled a cancer either from within or without. The middle of the stomach was removed by sleeve resection. Patient made a perfect recovery, developed ventral hernia, which was repaired six months later, at which time no evidence of recurrence could be detected, but the patient returned on the 7th of October, 1918, with a definite mass involving the liver, and all the evidences of cancer. He lived only a few months afterwards.

Thus, out of the entire 233 patients operated upon for gastric and duodenal ulcer, only 4 are known to have developed carcinoma, and 2 of these occurred in cases in which the ulcer area was excised; the other, if it was cancer at all, followed the Eiselsberg exclusion, and only one case, as far as we know, has developed carcinoma in the entire series of 165 simple gastro-enterostomies. However, I am frank to admit that we have not completed our follow-up system on these patients as we would like to, and other cases may show up later. The fact that we have been able to learn of only one case in the gastro-enterostomy list who has developed cancer, while there have developed 3 in the other much smaller list, is at least suggestive.

It is fair to state that the large saddle ulcer, on closer, later, microscopic examination, showed strong evidences of malignancy, so it had probably taken on malignancy when it was removed.

The case in which pylorectomy was performed was examined by an amateur hospital pathologist, and pronounced non-malignant. While we have not completed a systematic follow-up of all these cases, as far as relief of the morbidity is concerned, all the indications are so far that the general health of the patients who have had a simple gastro-enterostomy is better than those who have any of the radical or combined operations on the average.

In studying these cases from the four standpoints brought out in our opening sentences, we find the following:

From the standpoint of mortality, the simple gastro-enterostomy shows a total mortality of 4 in 165 cases, or 2.42 per cent. All other operations combined, including 67 cases, show immediate mortality of 6, or about 9 per cent. In the 165 cases of simple gastro-enterostomies, only two secondary ulcers have been known to result, while seven out of 67 of the more direct and radical operations, or more than 10 per cent., have developed

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secondary ulcers. Of 165 simple posterior gastro-enterostomies, only one case has developed cancer, while 2 of the 67 cases of excision are known to have developed cancer, and a third probably developed cancer.

As to the relief of morbidity, all the evidence we have at hand indicates that the simple gastro-enterostomies have given better results from the standpoint of the recovery of the patients than have any radical operations.

In discussing the question of cancer, of course, we must take into consideration that three-fourths of all the ulcers are duodenal. These practically never develop in cancer, so that the cancers following ulcer are limited entirely to the 25 per cent. found in the stomach.

Another thing to be considered in a spirit of fairness is that the borderline cases are most likely to be removed by radical operation. But making full allowance for all these matters from my own experience, I am fully convinced that the proper treatment of all gastric and duodenal ulcers from which the suspicion of malignancy can be removed with a fair degree of certainty, the proper procedure is as follows:

To do a gastro-enterostomy and await results, no matter where the ulcer is located, if trouble develops later, it is then time to open and do a radical excision. Excision, after a gastro-enterostomy has been performed, carries practically no mortality with it at all, no matter whether done with the Balfour cautery or by excision with a knife. The Balfour cautery seems much simpler, and can be done much quicker.

Concerning the *technic of gastro-enterostomy* we may briefly discuss the principles. I think it has generally been conceded that the best application of the jejunum to the stomach is a short loop with the application of the jejunum downwards and to the left, ending at the greater curvature of the stomach, as recommended by Dr. W. J. Mayo. The suture material is still debated. Dr. C. H. Mayo for a while thought the secondary ulcer was due in certain cases to these stitches. This, I believe, he concedes now is not always true. At least one of the cases reported in our series shows 5 recurrences, 3 of which I believe were performed by the use of catgut exclusively. Personally, I am afraid to risk catgut entirely, although I believe it is used at the Mayo Clinic with satisfactory results. It is true that the external non-absorbable thread of a gastro-enterostomy is usually found hanging in the base of a secondary gastro-jejunal ulcer if the ulcer exists.

In early experimental work on animals, I observed that an interrupted suture around an anastomosis, if it had penetrated the mucous membrane, would cut its way out in a few days. If the interrupted suture did not penetrate the lumen of the bowel, and was used as a Lembert suture, these sutures would remain encysted in the peritoneum for many months without giving trouble. A continuous linen or silk thread used for the inside suture was usually found for a few weeks after the operation, but eventually was thrown off in the bowel. The continuous suture, which was intended for the peritoneal suture, frequently penetrated the lumen of

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the bowel or stomach. Such a suture lying in the wound for months and even years, probably.

While I am not convinced that a large number of secondary ulcers are due to such sutures, I agree that a large continuous, non-absorbable suture can certainly do no good, and probably in many instances does harm. Therefore, I never use a continuous linen or silk thread in an anastomosis. An interrupted linen suture, if it penetrates the lumen, will free itself in a few days. If it does not penetrate it, it will remain encysted so it can in no possible way do harm. In our work, then, we have adopted the principles of several operators.

We never give a stomach patient a cathartic the night before operation. A high flushing of soda—a teaspoonful to a half gallon of water—another early in the morning. If obstruction is considerable, the patient is given warm water by the rectum every four hours during the night. The stomach is washed before patient is brought to the operating room. After the abdomen is opened in the median line, or slightly to the left, a stomach tube is passed into the stomach, all gas and any fluid remaining allowed to escape. The ulcer is examined. If it is a duodenal ulcer, and is on the anterior surface, the omentum from above and below is drawn across the duodenum to take care of any possible fat perforations. The transverse colon is lifted, peritoneal fold corresponding to the ligament of Treitz located, the middle colic artery identified. This artery is usually found about the peritoneal fold mentioned. The transverse mesocolon should be opened in the large arterial loop to the left of the middle colic, and to the left of the peritoneal fold. If the fold extends far down, it should be clipped. Usually, there is a very small vessel running diagonally across the space where the mesocolon is to be opened. This vessel sometimes bleeds enough to make the field bloody. With two forceps, one on either side of the incision to be made, the clear mesocolon is picked up and cut through, exposing the posterior wall of the stomach in the lesser curvature. By examining the stomach above and below, the operator may get his bearings and pick up the stomach wall with two forceps, one on the posterior surface of the stomach, above its middle, toward the pyloric end; the other forceps should be placed toward the cardiac end of the stomach and near the greater curvature. The jejunum is directed toward the left, a short loop is picked up, a fold of gauze is placed between the stomach and jejunum to catch any discharge of blood or contents. The jejunum is picked up about 2 inches from its origin. A linen suture is passed through the outer wall of the intestine and stomach, near the mesentery border of the jejunum. This suture should pass beneath the holding forceps, and when tied should take its place. Another suture of the same kind picks up the jejunum near its mesenteric border about 2 inches caudad to the first suture. This suture is then passed through the outer coats of the stomach beneath the forceps near the omental attachment. The forceps are removed; these sutures

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are used for traction loops. Another similar suture is then made to divide the space between these two loops. These spaces are in turn divided in the same manner, and so on until the required number of sutures are placed. These sutures are intended to go only through the outer coats of the intestines. However, if they happen to penetrate the lumen, no harm is done. After the row is completed, two quilt sutures are placed near the ends corresponding to the traction loops. After these penetrating quilt sutures have been tied, the first loops are cut away, and the deep penetrating loops are used for traction. A full line of quilt sutures are then placed between these two loops. These deep loops are made to grasp any large vessel which may show.

The walls of the stomach and intestine are then cut down to the mucosa until it herniates. A tannin catgut suture is then begun at the proximal end of the wound, and is made to penetrate the mucosa, and all thicknesses of the viscera. Large vessels along the stomach and intestines have all been caught with the forceps; a lock stitch passes down the whole length of the incision to serve the purpose of both strength and haemostasis.

At the distal end of the cut the stitch is securely locked, after which the stomach and intestinal cavities are opened. All bleeding vessels coming from the outside of the wound are caught. They may be either tied or held with forceps until they are caught in the continuous catgut suture. After turning the distal angle of the wound, the continuous suture is changed from a lock stitch to an in-and-out right-angle stitch, and continued to the point of beginning. This combination stitch was used by Dr. C. H. Mayo many years ago.

Having completed the circle, the middle row of deep penetrating quilt sutures are placed, after which the row of interrupted peritoneal sutures completes the anastomosis.

One of the important steps of a gastro-enterostomy is proper suturing the mesentery borders and the stomach and intestines. It is very important that each stitch is carefully watched to see that the intestines are not twisted in any way. The mesocolon should first be sutured to the stomach by a few interrupted linen sutures. After this line is completed, a fold of the loose mesentery is drawn over to the jejunum by a few interrupted sutures. The space between the jejunum and the mesentery is closed with interrupted linen.

## TECHNIC OF APPENDECTOMY

DESCRIPTION OF A RATIONAL, SAFE AND EASY TECHNIC OF THE OPERATION FOR ACUTE AND INTERVAL APPENDICITIS

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ATTENDING SURGEON TO THE GREENPOINT HOSPITAL

IN all cases of appendicitis, the ideal time to operate in order to obtain the most ideal results *quoad vitam* and *quoad functionem* is obviously the first few hours after the first attack; but as the surgeon cannot select his cases, but must take them as they come, he should adopt a line of conduct that will minimize the dangers *quoad vitam* and give the best results *quoad functionem* in all cases. Such a line of conduct has certainly been in the mind of every good, conscientious surgeon, but it seems to us that the technic followed nowadays in general routine work does not answer to all the *desiderata for a safe appendectomy in all acute cases*. We propose, therefore, a technic to be followed in all acute cases, that will make appendectomy safe, rapid and easy of performance in all cases, and will render some of the most difficult and dangerous ones, such as cases with a gangrenous retrocaecal appendix not diagnosed as such, easy and safe to operate, and give the most satisfactory after-results.

We shall not enter for brevity's sake into a detailed discussion on the pathology of appendicitis, and on the old and yet unsettled question of when to operate, subjects that are treated in another paper in course of preparation, we shall only mention certain points that are indispensable to make clear the reasons why we advocate the procedure to be described.

Obviously the surgeon has to adopt as his motto, *primum non nocere*, the possible danger in all acute cases being due to the fact that infection might be spread by the manipulations indispensable to the performance of the operation and the resistance of the patient lowered: these dangers are more pronounced the more advanced is the case and the more abnormal is the position of the appendix. An exact diagnosis of the possible extension and severity of the infective process, of the condition and location of the appendix, is practically impossible in the greatest majority of acute cases, if not in all; therefore the line of conduct to be followed by the surgeon must be such that no matter what are the extension and severity of the infective process, and the condition and location of the appendix, the operation will never *per se* be a coefficient, that instead of improving the chances of recovery of the patient, might have been a handicap to his recovery. The operation must therefore always aim to prevent the diffusion of the infective process<sup>1</sup> by not disturbing the adhesions that the peritoneum has built, and which are the best barrier against the spreading

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of infection and provide for a safe and positive exclusion of any infective material.

The infective process can become dangerous if it spreads to the abdominal organs contained in the peritoneal cavity; therefore the abdominal organs must be protected against any infecting material, and their resistance against infective agents must not be lowered. The best way to accomplish this is to operate in such a manner that no abdominal organ, through which infection can be spread, is disturbed or traumatized.

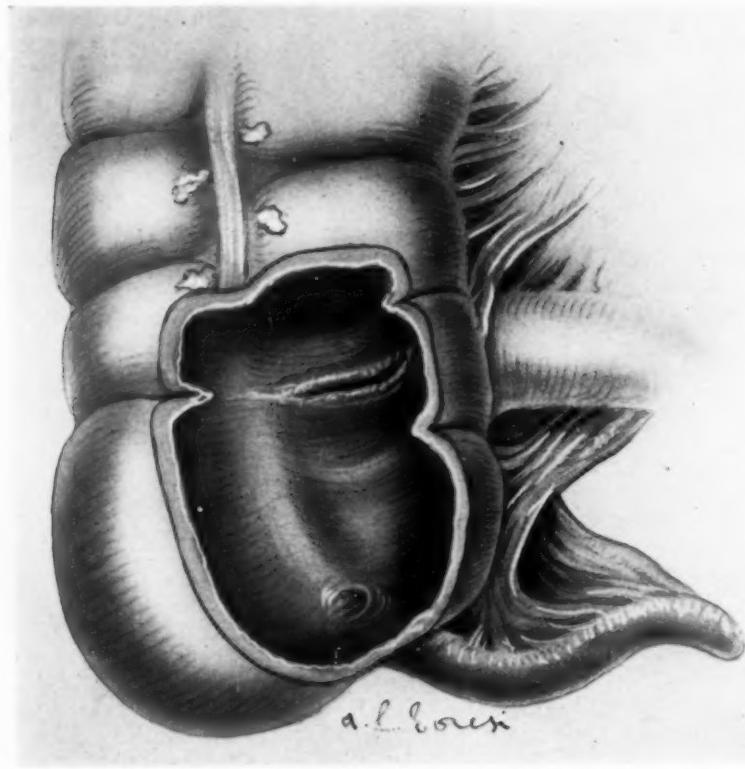


FIG. 1.—Normal position and relation of appendix (front view).

so that infection of the peritoneal cavity is absolutely prevented in all cases, no matter how advanced is the infection and what is the condition and location of the appendix; naturally, in the cases when the peritoneal cavity is already infected, the procedure we advocate can only aim to prevent a further spreading of the infection and not to weaken the resistance of the peritoneum.

The aim of the surgeon is the removal of the appendix. Naturally in order to remove the appendix the surgeon has to know first where the appendix is located. Is there a fixed position where the surgeon has the certainty of finding the appendix? No; what we call the normal position

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of the appendix and which is well illustrated in Figs. 1 and 2, is met only in a comparatively small number of patients among the ones who are operated for acute appendicitis, probably because the persons who have a perfectly normal appendix are much less subject to appendicitis than the persons who have what could be called an abnormal appendix. Anatomically the appendix might be short or long, have a very long or short meso, be thick or thin, be located in numberless positions (Fig. 3), and contract close relations or adhesions with any abdominal organ (Figs.

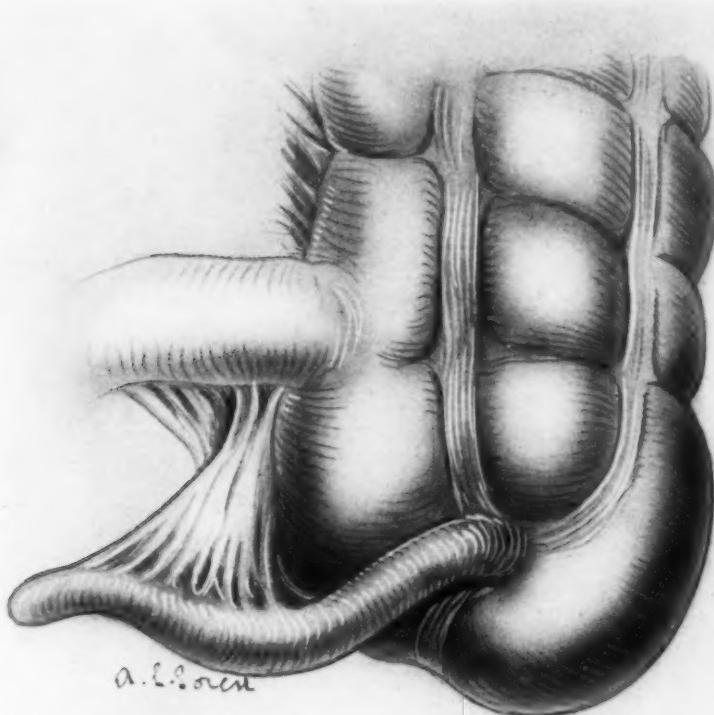


FIG. 2.—Normal position and relation of appendix (back view). Note in Figs. 1 and 2 that point of emergence of appendix, from cæcum, or base of the appendix, is a fixed point in all cases, whence the appendix can be traced and located very easily.

3 and 4). However, no matter how changeable are the shape, position, size and relations of the appendix, there is one point which is always fixed; this point is its implantation on the cæcum, or what could be better called, its base. The base of the appendix is located in all cases on the inferior inner side of the cæcum, two or three centimetres below the ileocæcal valve, exactly at the meeting point of the three muscular bands of the large intestine; this point is called the fixed appendicular point (Testut et Jacobs—*Anatomie topographique*) (Figs. 1, 2, 3, 4, 5, and following). This point is so fixed that when the cæcum is not in its normal position,

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the base of the appendix is found to have also the same abnormal relations of the cæcum (Figs. 5, 6, 7, and 8). If anatomically the diseased appendix has no fixed position the search for it becomes more difficult on account of the pathological conditions resulting from appendicitis. Indeed, as soon as an inflammatory process of the appendix takes place, the peritoneum reacts in order to limit the infective process by creating adhesions; therefore, on opening the abdomen the surgeon will always find

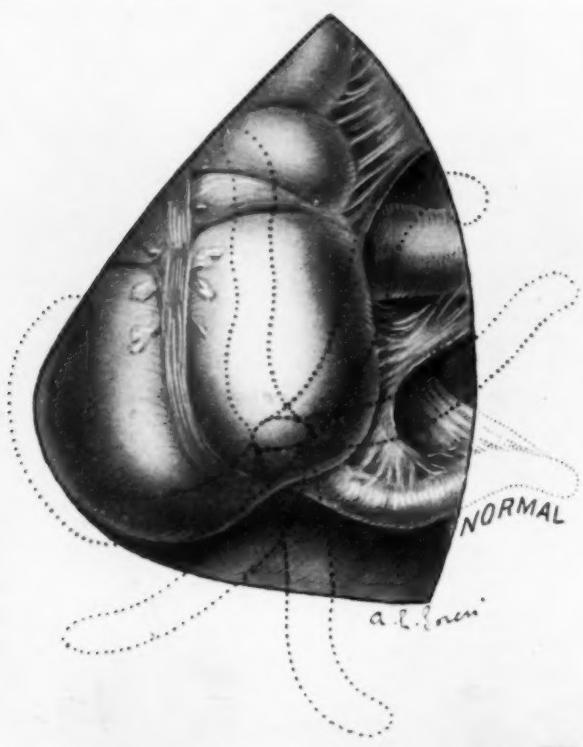


FIG. 3.—Ordinary position of the appendix. Normal position is marked so, but any of the other positions are met very frequently at operation and in post-mortems, and are compatible with perfect health. Note difficulty of tracing the appendix through the McBurney incision, when the appendix is not in its normal position.

in the advanced cases more or less abundant and dense adhesions binding together some of the intraperitoneal organs; these adhesions might also include a collection of pus, blood, serum, fecal matter, etc., which collection might be completely walled off and therefore separated from the general peritoneal cavity, or might be diffused more or less in the peritoneal cavity itself. At any rate, the presence of adhesions makes the search for the appendix more difficult and always more or less dangerous for the patient. Indeed, to search for the appendix in an acute case means that a number of the adhesions must be broken, even if the appendix is in a rather accessible position as shown in Fig. 9, because even if the surgeon should be so fortunate as to

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fall immediately on the appendix, he must loosen up the parietal peritoneum, the omentum (which was removed in the illustration in order to make it clearer), must break the adhesions found in immediate contact with the appendix and between the inner portion of the cæcum and the loops of ileum, in this manner opening numberless avenues through which

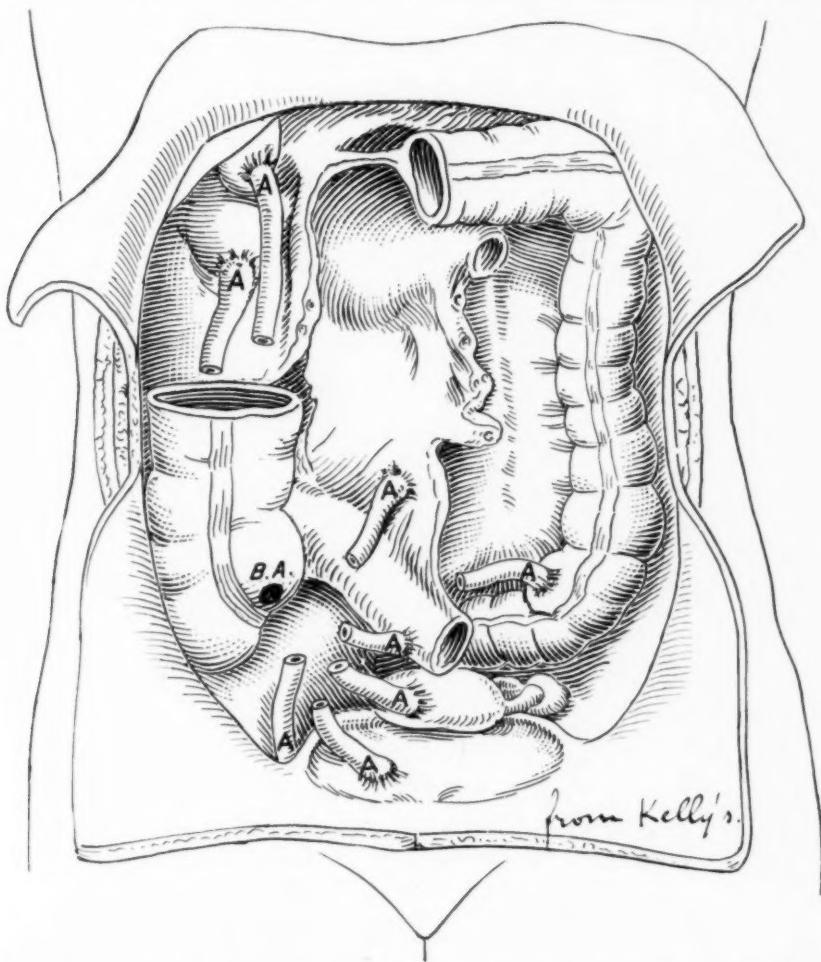


FIG. 4.—Possible locations of appendix (A) and relations that it can contract with any other abdominal organ. Note that whatever the position of the appendix, its base is always found in the normal position (B.A.) and can be traced from that point. (From Kelly's "Appendicitis.")

infection can be spread. Matters are even worse in a case such as the one sketched in Fig. 10, where the appendix cannot be seen and may be located anywhere, so that in the search for it the surgeon must break numberless valuable protective adhesions and spread infection. If we add to all this the inconvenience of working, as is often done, through a small McBurney incision, the trauma caused by retractors, pads, surgeon's hands, the possible breaking of an abscess, etc., we have not to

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FIG. 5.

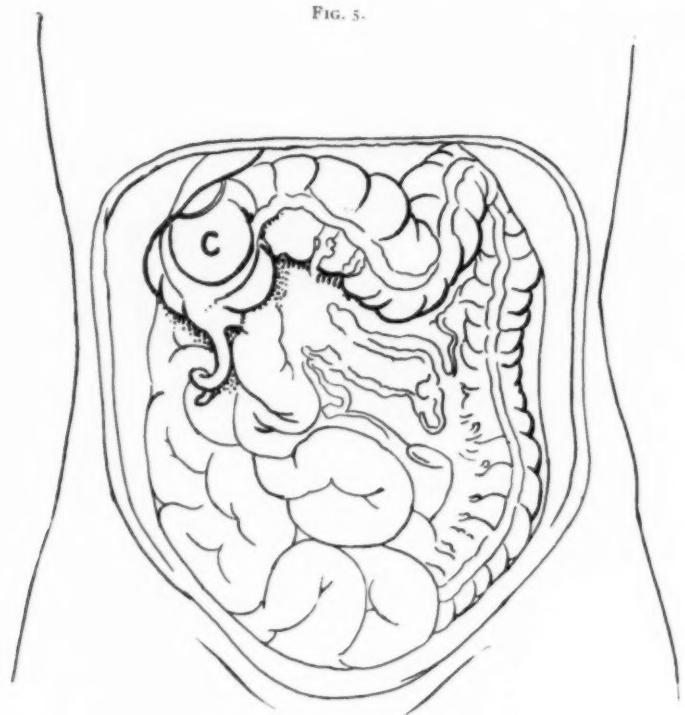
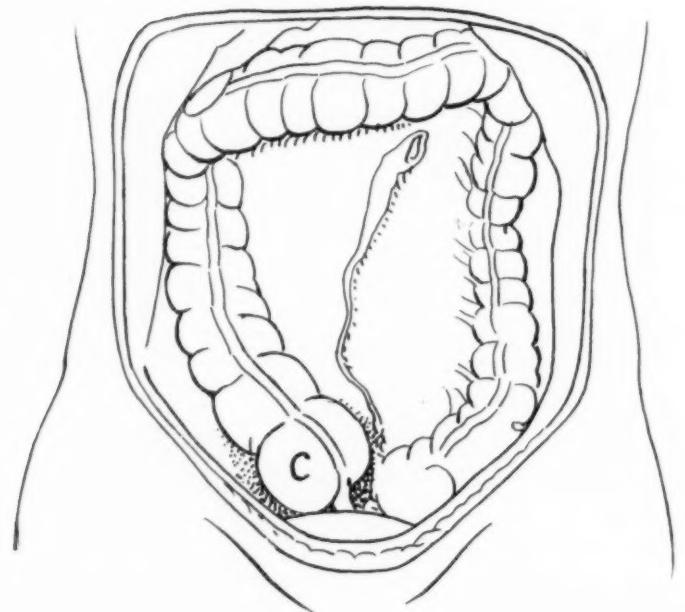


FIG. 6.



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FIG. 7.

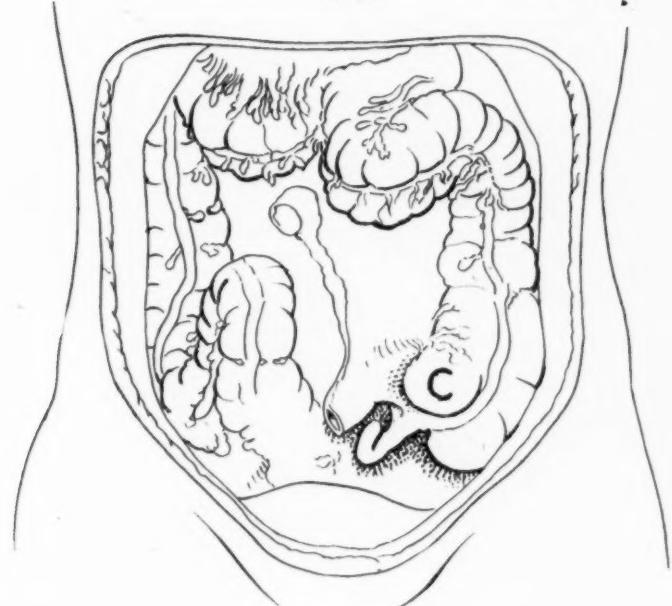
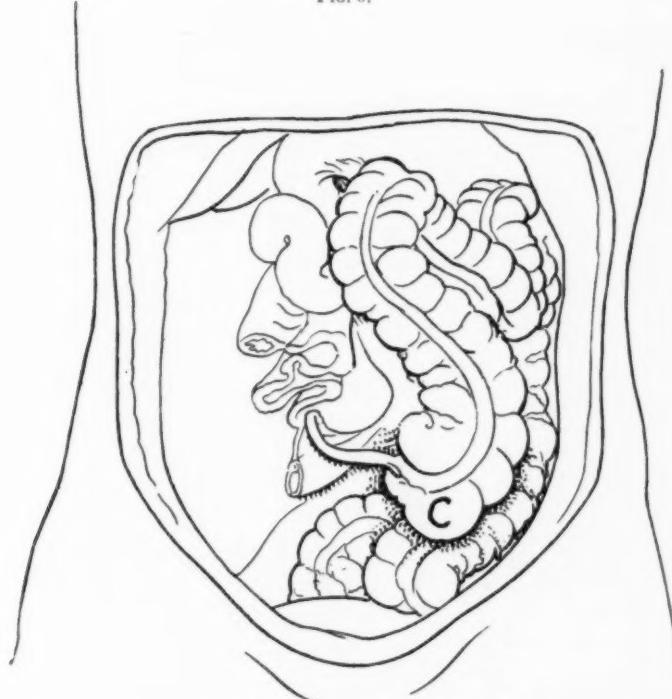


FIG. 8.

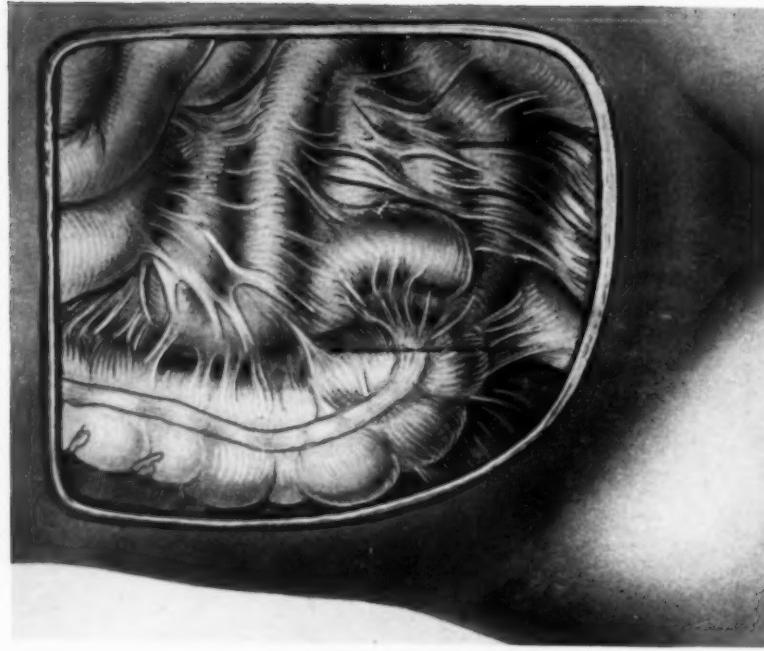


FIGS. 5-8.—Show the possible positions of the cæcum (C); the base of the appendix, however, has always normal relations with the cæcum.

FIG. 9.



FIG. 10.



FIGS. 9-10.—Schematic views of protective adhesions as found in cases of appendicitis. In Fig. 9 the perforated appendix is visible through the adhesions; in Fig. 10 the appendix is not visible; in both cases the omentum was removed to make the illustrations clearer, but evidently the omentum would also contract adhesions. Note that if the usual technique is followed in looking for the tip of the appendix, a number of valuable protective adhesions are broken; when, instead, the surgeon follows our technic, the protective adhesions are not disturbed. Dotted lines show how pararectal incision falls on the base of the appendix.

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wonder that some patients still die after appendectomy, and many complain of post-operative troubles. We believe that all surgeons will agree that in acute cases the protective adhesions built by the peritoneum must be preserved as much as possible, as the most valuable barrier against the spreading of infection. We can add, from a very exhaustive work on adhesions to be published soon, that all inflammatory adhesions do generally disappear completely a certain time after the inflammation has subsided, but that traumatic infected adhesions, resulting from the breaking of inflammatory adhesions, do not disappear as easily as the purely inflammatory ones; more often they become denser and thicker in the course of time, and might therefore be the cause of serious and dangerous complications. This point is exceedingly important, because if in acute cases of appendicitis the surgeon must be concerned in saving life, more than in anything else, it is logical to state that he should operate in such a manner that he should preserve all the coefficients that will help him in saving life and at the same time give good post-operative results, when these coefficients, as the protective adhesions, do help in saving life and giving satisfactory post-operative results.

Can the surgeon locate and remove the appendix without breaking the protective adhesions built by the peritoneum and without spreading infection, no matter what are the condition and location of the appendix? We answer yes, if the technic we advocate, and which is the opposite of the technic adopted nowadays, is followed. This technic is based on the following principles: First, *never look for the tip of the appendix which is difficult or impossible to find, but look only and in all cases for its base, which can be found very easily, safely and quickly.* Second, *keep away from the peritoneal cavity.* Third, *do not use protective pads; work always in the open, seeing exactly what you do and how you do it, knowing that it is exactly what you want to do and that it is done as you want it to be done.*

*Locating the Appendix.*—Figs. 11 and 12 show two schematic cross-sections of the right abdomen, corresponding about to the base of the appendix. A perforated appendix is surrounded by a collection of pus; a line divides the cross-section in two portions which are called safety-land and dangerland. Safetyland includes the two external thirds of the cæcum with the base of the appendix; dangerland includes the internal third of the cæcum and the general peritoneal cavity. In Fig. 11 the appendix is located in the general peritoneal cavity; in Fig. 12 the appendix is located under the cæcum; in both a perforated appendix is surrounded by a collection of pus. The parietal peritoneum, the cæcum, the omentum, and the loops of small intestine are adherent more or less firmly to each other (in these schematic illustrations the omentum and the adhesions were omitted in order to avoid any confusion and make clear the points we want to bring out). If the surgeon makes his incision as commonly done, loosens up the parietal peritoneum and the omentum on the side of dangerland and proceeds to locate and remove the appendix following

FIG. 11.

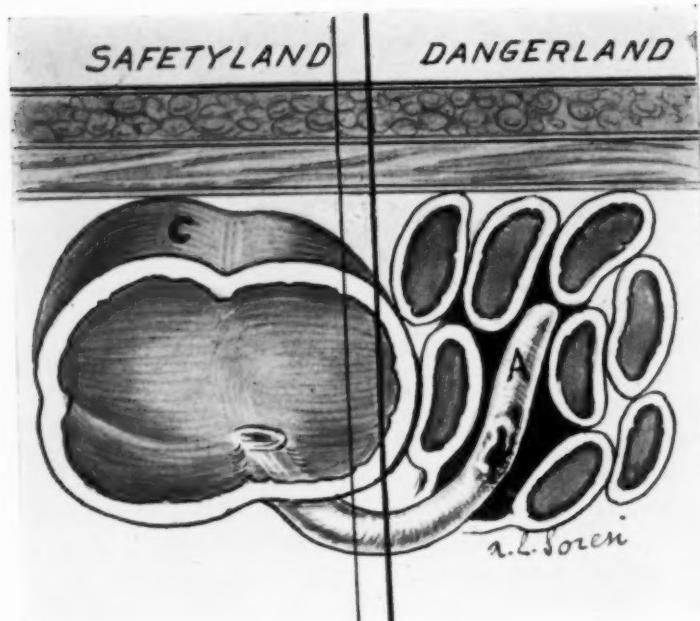
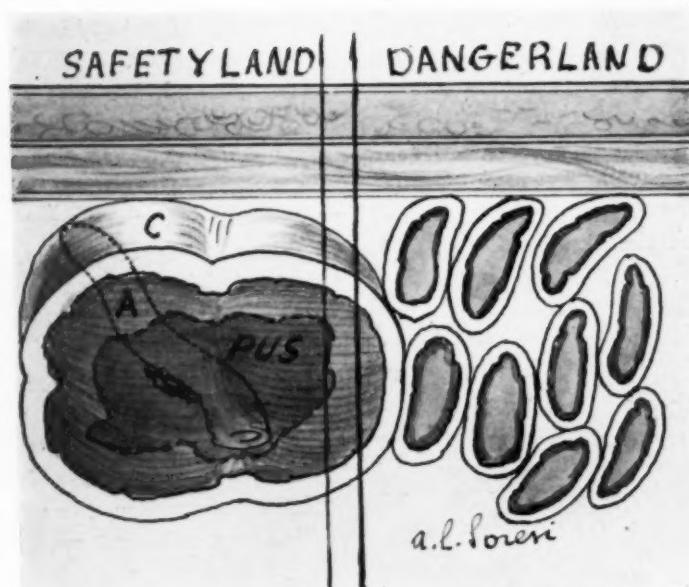


FIG. 12.



FIGS. 11-12.—Schematic views of two typical perforated appendices with abscess formation, showing that in both cases, even if not diagnosed before operation, by working only on the safety-land, the appendix can be easily removed without spreading the infection and proper drainage can also be applied.

## TECHNIC OF APPENDECTOMY

the actual technic adopted by many surgeons, even in the cases in which there is a superficial collection of pus, as represented in Fig. 11, and when he is extremely fortunate in locating and removing speedily and without the slightest trouble the whole appendix, we repeat, even in absolutely the most favorable cases *he will positively have broken valuable protective adhesions and spread the infection to the parietal peritoneum, to the omentum, to the cæcum, to several loops of intestine, and around the ileocecal valve and no one can know if the infection is not going to spread further.*

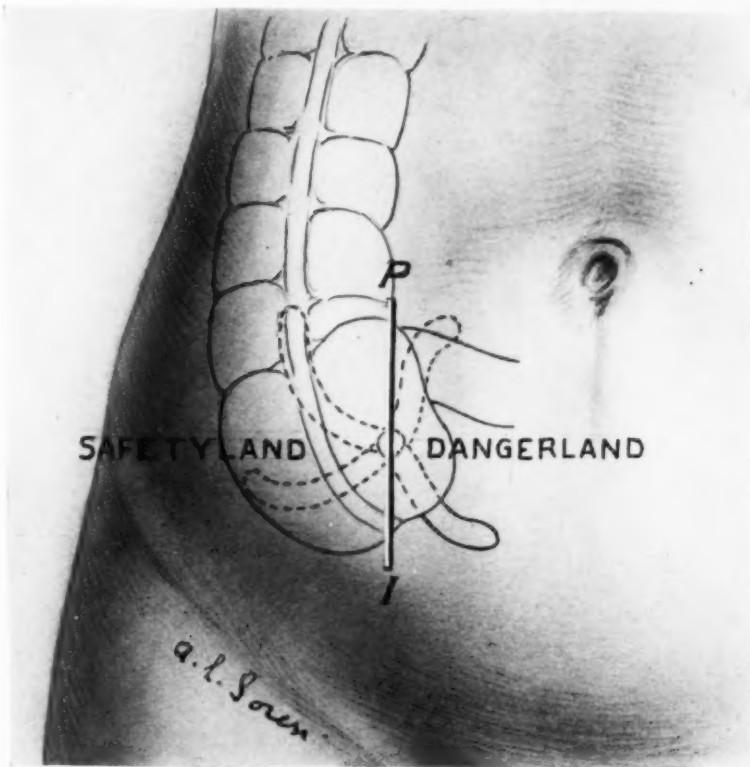


FIG. 13.—Cæcum outlines on the abdominal wall, showing how pararectal incision (P) falls on the base of the appendix and on what side (safety-land) the surgeon can work safely without breaking any protective adhesions. (See Figs 9-12.)

We took as an example the most favorable case, but suppose that the surgeon has to deal with a case where the continuity of the appendix is interrupted and its c'ébris lost in the collection of pus (Figs. 22 and 23), or with a case where it is difficult or impossible to locate the appendix, or the appendix is retrocecal as shown in Fig. 12; any one can easily imagine the damage he would cause by breaking numberless valuable adhesions and spreading the infection, who knows how far.

It is not uncommon to see surgeons who are dealing with so-called bad acute cases, remove only a portion of the appendix and then close the

base as well as possible under the circumstances, or not even attempt closure at all, but limit themselves to putting in a drain and hope in good luck (Fig. 22). This procedure is due to the fact that when adhesions and pus are present and the patient is not in good condition, the surgeon rightly feels that he has to get out of the abdomen as rapidly as possible; he finds it difficult or more often impossible to horizon himself; knows that to try to locate the appendix means the breaking of numerous

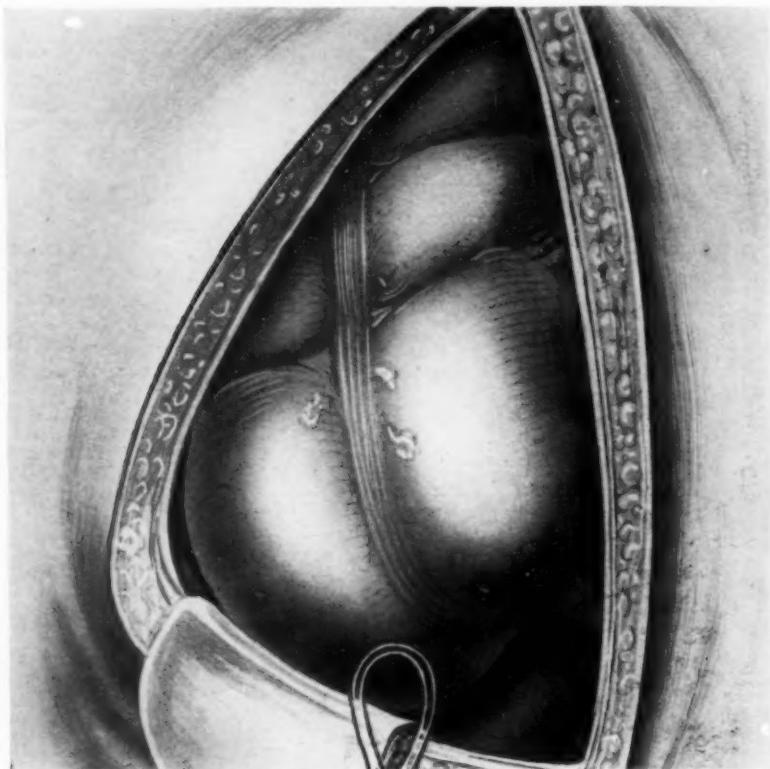


FIG. 14.—Shows how and where to apply blunt retractor in order to expose cæcum and where to apply sponge-holder (which must be covered with rubber) to cæcum in order to expose base of appendix. (See Fig. 15.) Adhesions have been omitted to make the illustration clearer.

protective adhesions, and therefore feels compelled to resort to what must be called, at best, a makeshift. Could any one feel satisfied with such work done to himself, if he should need an urgent appendectomy?

Let us see how the technic we propose *for all acute cases can take care of any condition the surgeon might meet most unexpectedly*. We never use the small McBurney incision, but use an incision that will lead us to the internal third of the cæcum which corresponds to the base of the appendix (Figs. 1, 2, and 13); therefore, we make a pararectus incision beginning a couple of centimetres below the umbilical line and extending

## TECHNIC OF APPENDECTOMY

downwards about eight or ten centimetres (Fig. 13). When the peritoneum is reached it is freed from probable adhesions binding it to the cæcum, *but only on the external side; we do not, for any reason, even touch the internal edge of the peritoneum, much less try to free it from any adhesions binding it to the cæcum.* We keep always outside of the border between safetyland and dangerland; raise up the peritoneum and apply a

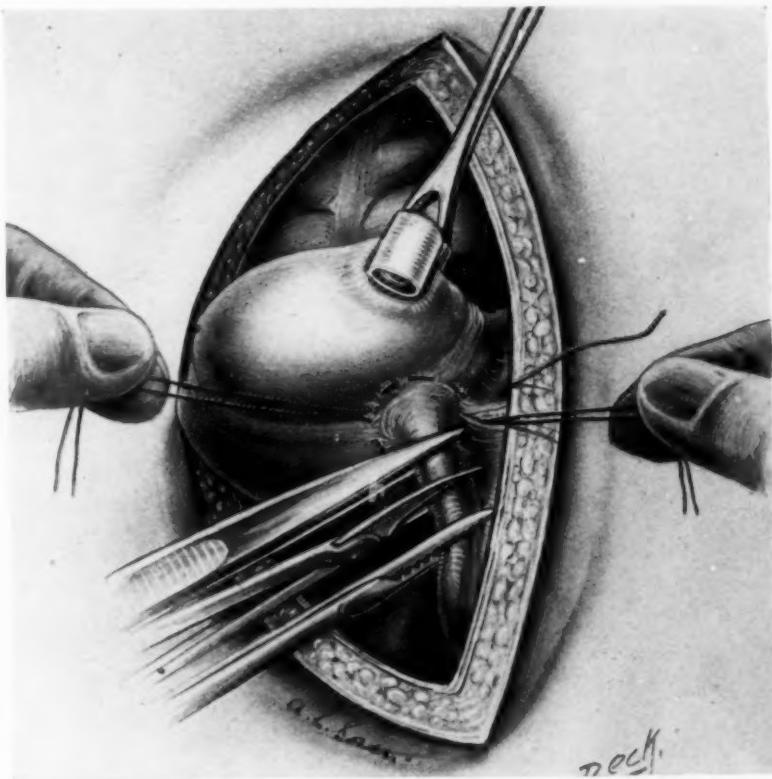


FIG. 15.—The two outer thirds of the cæcum have been freed from adhesions and lifted up inwardly; the base of the appendix freed from adhesions and exposed; the special purse-string suture applied; the assistant holds the four threads, forceps are applied and the appendix severed. (The appendix was exposed quite freely and the instruments, forceps and scissors, were put wide apart from each other in order to render the picture clearer. In actual work it is only necessary to expose about one centimetre of the appendix and the appendix must be cut close to its base; the two forceps should be put so close as to leave only room for a thin pair of scissors to cut through between them.)

blunt retractor to the outer edge of the incision close to its lower angle (Fig. 14), and raise up the cæcum with a soft sponge-holder covered with rubber applied to its lower external portion (Figs. 14 and 15). Naturally the cæcum must be freed from occasional adhesions. Do not apply any pads and do your dissection preferably with sharp instruments, making haemostasis as you proceed by tying in small masses with the finest plain catgut the tissues that might bleed. Even in the worst cases the liberation of the outer portion of the cæcum is not difficult, because there is no

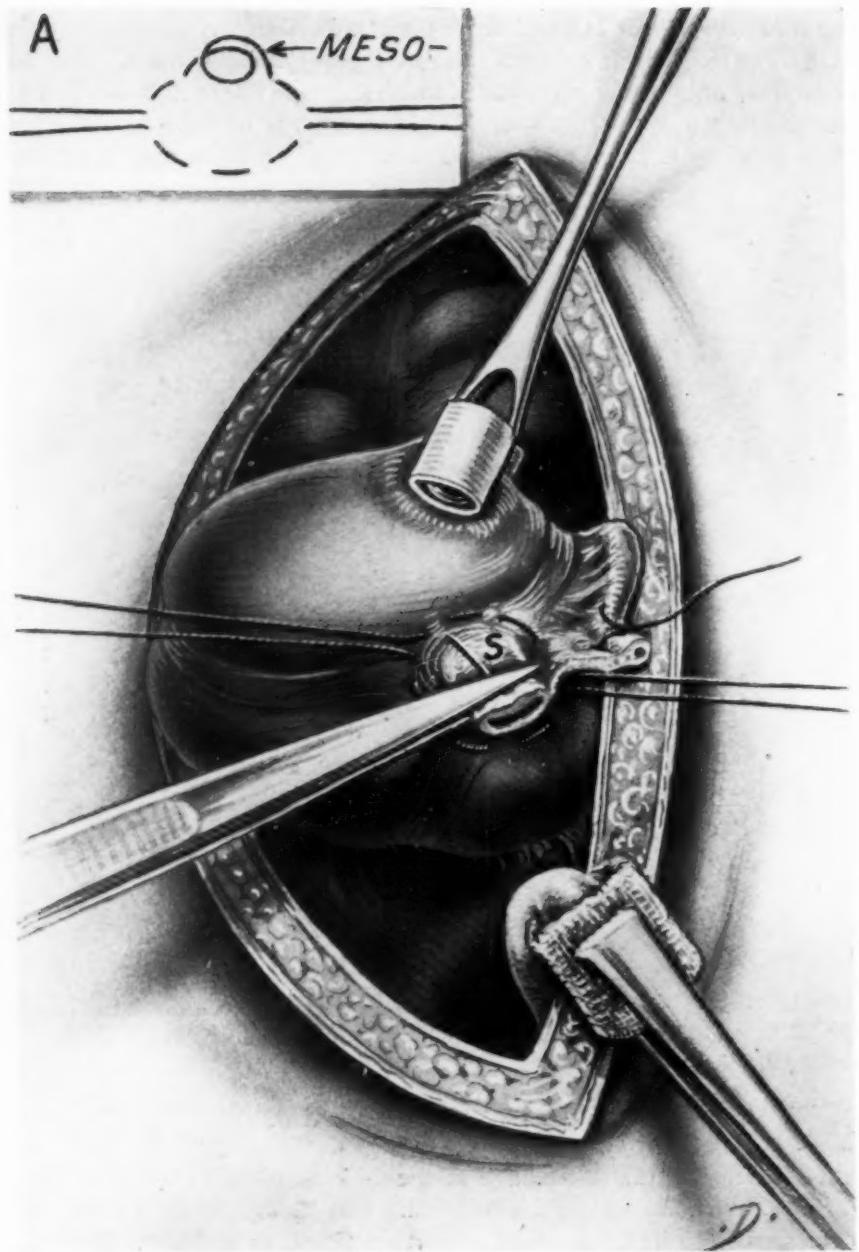


FIG. 16.—The appendix has been cut close to its base, the distal portion covered with gauze and secured with a Museux or other suitable forceps. The base of the appendix is slit within the line of suture (S) in case the cæcum and appendix are very thick. Sketch A shows how to secure haemostasis of the appendicular blood-vessels without resorting to tying the meso separately.

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other organ in contact with the cæcum and so there is no danger of injuring anything but the cæcum itself, and injury to the cæcum can be avoided easily by any good surgeon. Once the cæcum is raised up the base of the appendix will be seen very easily; free gently about one centimetre of the appendix from adhesions, if necessary, and surround its base with a purse-string suture made with plain catgut No. 0 or 1, entering the lumen of the gut (Fig. 15). At half suture the catgut forms a loop about ten centimetres long, and then the suture is completed. The catgut loop is cut and then the assistant takes hold of the four threads and with their help lifts up the base of the appendix (Fig. 15); the meso-appendix can either be tied and cut between two ligatures, or can be disposed of by

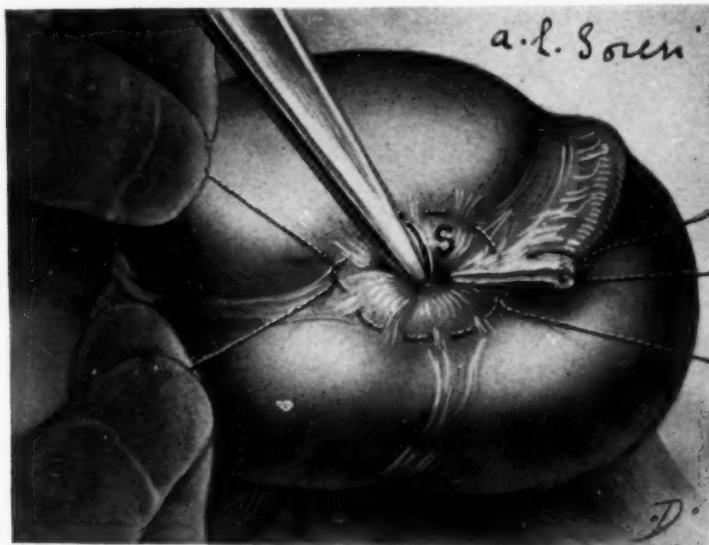


FIG. 17.—Inversion of stump of appendix in the cæcum—while assistant holds the forceps and two threads, the surgeon ties the other two threads.

passing behind it the catgut that is used to make the purse-string suture, as shown in the sketch attached to Fig. 16 (*A*), and pulling the thread taut over the meso; the distal portion of the appendix is clamped, the surgeon catches with a thumb forceps the base of the appendix and severs it with scissors (Fig. 15); the assistant holds temporarily the thumb forceps with either hand while always holding the four threads; the surgeon quickly covers the cut end of the distal portion of the appendix with a piece of gauze kept in place by a Museux or other suitable forceps, drops it temporarily (Fig. 16), and inverts the stump of the appendix into the cæcum, while the assistant holds the cæcum itself by means of the four threads (Fig. 16). If the cæcum is very thick a slit can be made in its wall within the purse-string suture (Fig. 16), so that in all cases the inversion of the stump of the appendix is made not only possible but very



FIG. 18.—Inversion of stump of appendix completed, forceps are removed; the other two threads are tied.

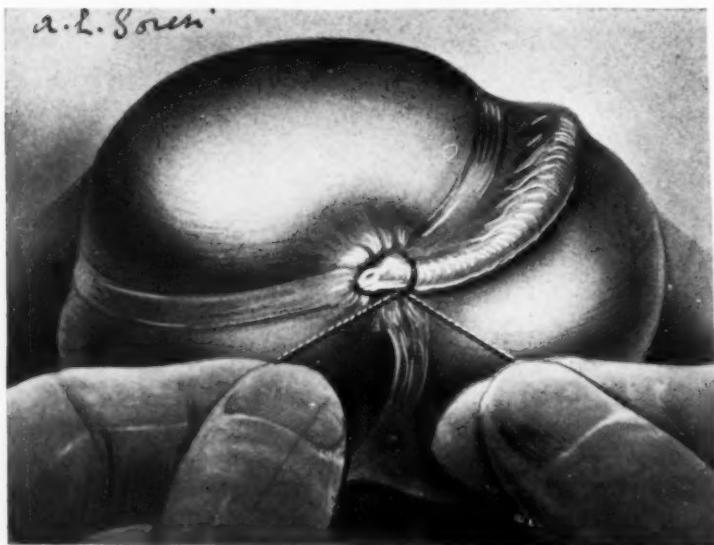


FIG. 19.—Area from which stump of appendix was removed is covered, when possible, with meso-appendix.

easy. The assistant passes two of the four threads to the surgeon, and with the hand that he has free takes hold of the thumb forceps; the surgeon pulls the threads rather taut and ties them, while the assistant holds steadily the opposite two and the thumb forceps (Fig. 17); then the surgeon takes hold of the other two ends of the threads, pulls them very

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taut and ties them (Fig. 18), while the assistant removes gently the forceps; the inversion of the stump of the appendix is completed; if there was a long meso-appendix it can be brought over the area where the

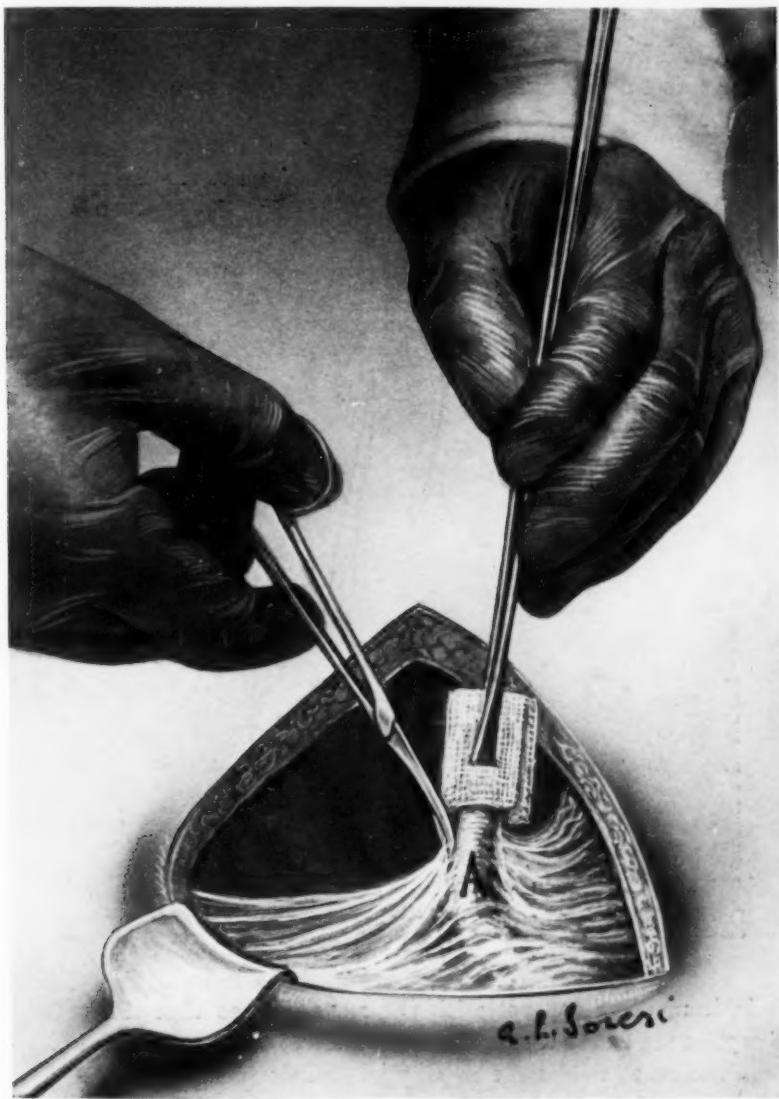


FIG. 20.—Surgeon takes hold of distal portion of appendix (A) and frees it from adhesions.

stump has been inverted by tying together one of the threads used in the purse-string suture and one end of the thread used in tying the meso (Fig. 19).

The surgeon now takes hold of the Museux or any other clamp used to catch the distal portion of the appendix and proceeds to free the

appendix itself from the adhesions that surround it. The liberation of the appendix is done with the help of scissors which alternate sharp and blunt dissection according to circumstances (Figs. 20 and 21), while haemostasis is made whenever it is necessary; if the dissection is properly made bleeding will be practically *nil*. It is evident that the liberation of the appendix is easy, because the surgeon has only to follow the appendix itself, and this can be done without disturbing the protective adhesions, because the only portion of the adhesions which is disturbed is the layer

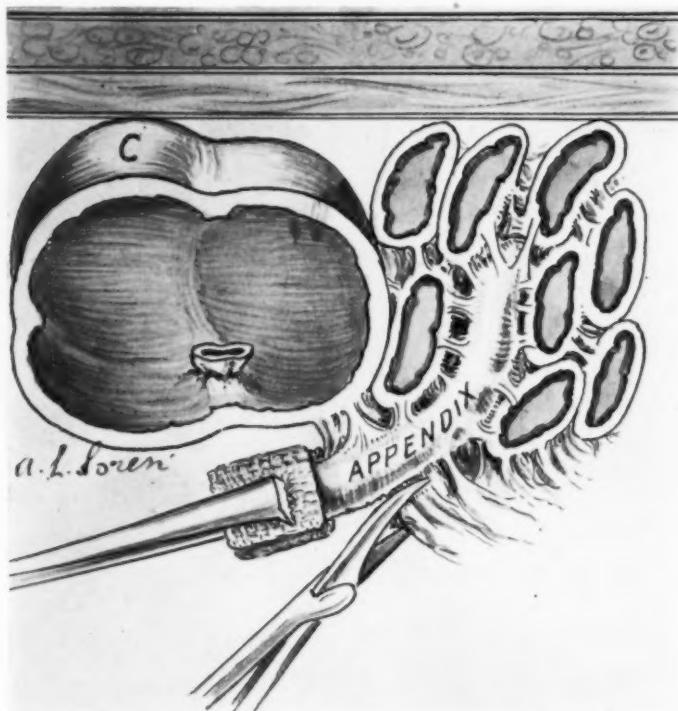


FIG. 21.—Schematic cross-section, showing how freeing the appendix is easy and can be accomplished without breaking any protective adhesions even in the worst cases, when the freeing is done as recommended in the paper.

that is in immediate contact with the appendix, so that the other peritoneal organs are never touched or even disturbed.

There are cases where the finding and removal of the whole appendix would be next to impossible without causing so much trauma and diffusion of infective material as to be fatal to the patient. These are the cases where the continuity of the appendix is interrupted by gangrene and the débris of the appendix are lost in what might be a limited abscess or among more or less firm adhesions that result from a more or less diffused peritonitis. In these cases the superiority of the technic we recommend becomes very plain. Indeed, when the usual technic is followed the most

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valuable adhesions, that is, the adhesions between the parietal peritoneum and the line between safetyland and dangerland, are broken as the first step in locating the appendix, so laying open the peritoneal cavity; but this is not the only and gravest danger. Indeed, even if after having broken numberless valuable adhesions and spread infection, the surgeon finally succeeds in finding and removing the tip of the appendix he might not be able to get at the base, as stated before, and therefore a dangerous condition results. Fig. 22 shows that the tip of the appendix has been

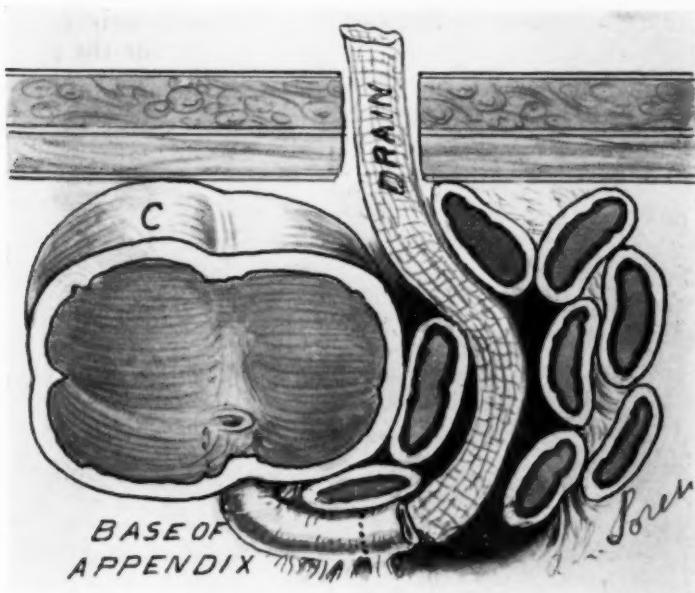


FIG. 22.—Schematic cross-section, showing what dangerous condition may arise when the base of the appendix is not secured and only the tip is removed, as it happens when the appendix is gangrenous if the ordinary technic is followed. Protective adhesions have been broken, the appendix might be left open, or badly tied on dotted line, and pour septic material into the abdomen; an irrational drainage is applied; result: general peritonitis and death or fecal fistula, sloughing of tissues, hernia, necessity of secondary operation in the fortunate cases.

removed, but the proximal portion is lost in the débris that formed around the gangrenous appendix. Fig. 23 shows instead that the proximal portion of the appendix has been removed and its opening in the cæcum sealed, but the tip of the appendix is left in the abdominal cavity. Which is the most dangerous condition, the one represented in Fig. 22 or the one represented in Fig. 23? In the condition represented in Fig. 22 we see that numerous valuable defensive adhesions have been broken, the peritoneal cavity is open to infection, and the cæcum is in direct communication with the peritoneal cavity into which septic material will be poured, so that general peritonitis will ensue, or in the fortunate cases a fecal fistula will form. In the condition represented in Fig. 23 we have not opened the general peritoneal cavity; we have done practically an extraperitoneal

operation, but the tip of the appendix is left in. Can its presence constitute an actual danger?

We can answer that if proper drainage is instituted there is absolutely no danger in not removing the tip of the appendix; on the contrary, it would be extremely dangerous in some cases to even attempt to locate it. In fact, if the technic which we have described above is followed, the cæcum is completely and securely closed in all cases, then the appendix is followed and freed; if in doing so the surgeon reaches an area where there is pus, and the appendix is lost in it, he has only to institute a proper drainage in order to feel sure that he has done the proper thing.

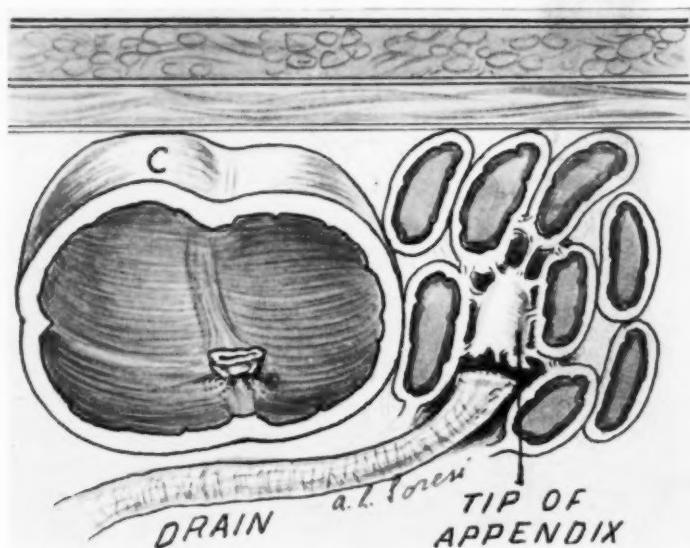


FIG. 23.—Compare this cross-section with the one shown in Fig. 22. Here we suppose the same gangrenous appendix; the base of the appendix was secured first; the tip could not be removed and is left in; no danger; the tip will be partly eliminated and partly absorbed; it is possible to apply a rational drainage; result: no protective adhesion broken, life saved, no fecal fistula, no sloughing of tissues, no hernia, no necessity of secondary operation.

for his patient. Indeed, the tip of the appendix is practically dead tissue, and having no communication with any other organ and no blood supply, must fall in complete gangrene and slough off. Therefore, if proper drainage is instituted the sloughing of the tip of the appendix will not be dangerous, because the products of its disintegration will partly be carried out with the other débris of tissues, and partly completely surrounded by protective adhesions, and so finally absorbed. If any attempt is made to locate and remove the tip of the appendix valuable protective adhesions will be destroyed, the infective process diffused, and the safety of the patient greatly endangered. We have, however, stated that proper drainage must be instituted and we must emphasize this most important point.

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*The Drainage of the Infected Area.*—In dealing with drainage of the abdominal cavity we have to take into consideration the following facts: The peritoneum reacts very promptly and energetically against infective agents and foreign bodies by isolating them with adhesions which will be more valuable and more rapidly formed the stronger is the resistance and vitality of the peritoneum and the more irritating is the infective agent or foreign body. It is therefore ridiculous to insert a piece of gauze or a rubber tube in the abdominal cavity and take it out through the laparotomy wound with the hope that all the septic material will be drained out; such a drain will only irritate the peritoneum, which when in good condition will set up strong and valuable adhesions; when, on the contrary, it has been badly infected and traumatized, it will react very poorly and not set up immediately valuable adhesions, so that the presence of the gauze or tubes will only help in the diffusion of the septic process. *A drain put between peritoneal organs can only carry out material that is collected in a cavity limited by adhesions, but can never drain the general peritoneal cavity*, because, as we stated, when the peritoneum is in good condition it builds up immediately adhesions that will limit the infective process; when in poor condition and not able to build up a valuable defense, the spreading of infection will not only not be prevented by the drainage, but in many cases the drainage itself might be a strong coefficient in spreading infection. We insist on this fact, because the secretions that collect in gauze or drainage tubes are a good culture medium for the microorganisms which will be protected against the active action which the peritoneum would set up against them, because they are embedded in the meshes of the gauze or inside of the tube. We shall not discuss all the points relating to drainage of the abdominal cavity, because it would take many pages and we have dealt with it in many articles; we will only state that it is irrational to drain with gauze, cigarette drains, or tubes put in the abdominal cavity and brought out through the laparotomy wound. They are irrational and dangerous, because they help the infective process, they infect the laparotomy wound, so predisposing the patient to post-operative hernia and might cause serious trouble by their presence, and finally they do not actually drain. This last point needs a special mention. Liquids can only come out of a cavity when they fall out of it by gravity or are pushed out by pressure (Fig. 24); a drain put in the abdomen through the laparotomy wound evidently cannot drain by gravity, can therefore only drain when the liquid is under pressure, which means that there must be a certain accumulation of liquid which is pushed out by the pressure exercised upon it by the walls of the cavity in which it is enclosed; the absurdity of such a condition does not need to be emphasized. Gauze and cigarette drains are supposed to drain by capillarity, but it is sufficient, as we have demonstrated in other papers, to think that pus is a suspension of corpuscles that will immediately occlude the tubules that constitute the

capillarity of the gauze, to understand that capillary drainage of organic liquids, as dense as pus, is a physical impossibility. *The first and most important factor for effective drainage of the peritoneal cavity is the preservation of the adhesions which the peritoneum has built up in order to limit the spreading of the infective process, no matter how thin and delicate these adhesions are.* We repeat we can only aim to drain the cavity that has been limited by adhesions; this cavity will shrink and finally become occluded if the process of repair on the part of the peritoneum is not hampered by the work of the surgeon. This is the reason why we have been so careful in limiting the dissection of the appendix from the adhe-

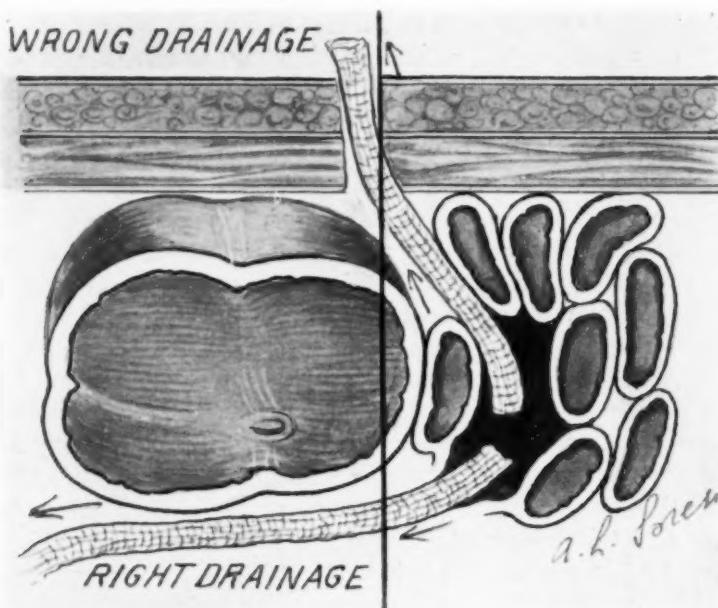


FIG. 24.—Schematic cross-section, showing right and wrong manner of draining a collection of pus. The right drainage drains by gravity, the wrong does not drain because liquid cannot climb uphill, and therefore is irrational.

sions that surround it. Next in importance is that drainage has to follow the law of gravity (Fig. 24); therefore, the drainage has to be carried out through a stab wound made in the most dependent portion of the region to be drained; in cases of appendicitis a stab wound in the flank will serve the purpose; in the woman when the appendicular abscess is contiguous to an abscess around the adnexa, a stab wound through the cul-de-sac of Douglas is advisable and to be recommended (Fig. 26). Third, the means used as drainage should really drain and should not cause any complications that might be due to its presence. Glass and rubber tubes are therefore most dangerous, especially on account of the fact that they may cause pressure gangrene.

The ideal drainage is constituted by strips of gauze dipped in melted

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paraffine and properly placed. Gauze covered with paraffine constitutes the ideal drainage, because to paraffine nothing adheres, so that between the paraffinated gauze and the tissues there will be always a space through which the pus will drain out by gravity (Fig. 24); paraffinated gauze adapts itself to the organs to be drained, does not irritate them, and obviously constitutes a solid body that cannot harbor any microorganism; paraffinated gauze does not need to be changed, thus avoiding any trauma or secondary infection due to introduction of a new drain. The

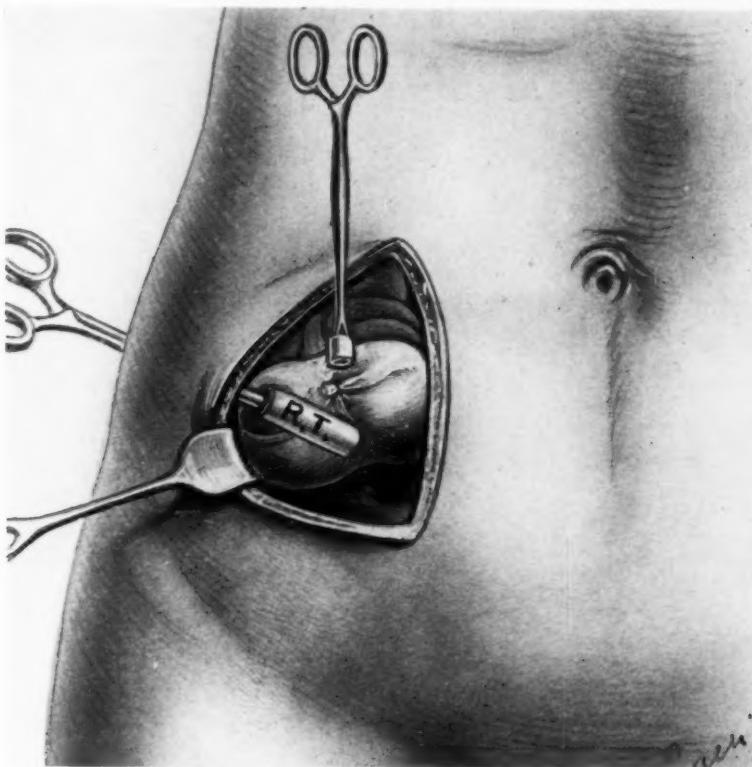


FIG. 25.—Manner of applying the paraffine gravity drainage. R. T., rubber tube paraffinated passing through a stab wound in the flank; the tube should not extend into the abdominal cavity but only pass through the abdominal wall.

gravity drainage has the other immense advantage of allowing a complete perfect closure of the laparotomy wound, even in the most infected cases, as explained later, so preventing post-operative hernias.

The paraffine gravity drainage is applied as follows: One or more strips of gauze about two centimetres wide are dipped in melted paraffine and allowed to stiffen; if a cavity with pus is met and when the tip of the appendix can not be removed, a strip of the paraffinated gauze is put in immediate contact with the cavity to be drained and can be secured in place by a stitch of thin catgut tied with only one knot (Fig. 25);

it is brought under the cæcum and out through a stab wound made as far back in the flank as possible (Figs. 25 and 26). The stab wound through the flank is lined with a rubber tube (Fig. 25) that has also been dipped in melted paraffine, and which should not itself extend into the peritoneal cavity, but should go only through the skin, muscles and fascias (Fig. 25). The paraffinated gauze is brought out through the rubber tube; this is done because the muscles at times contract so energetically that they

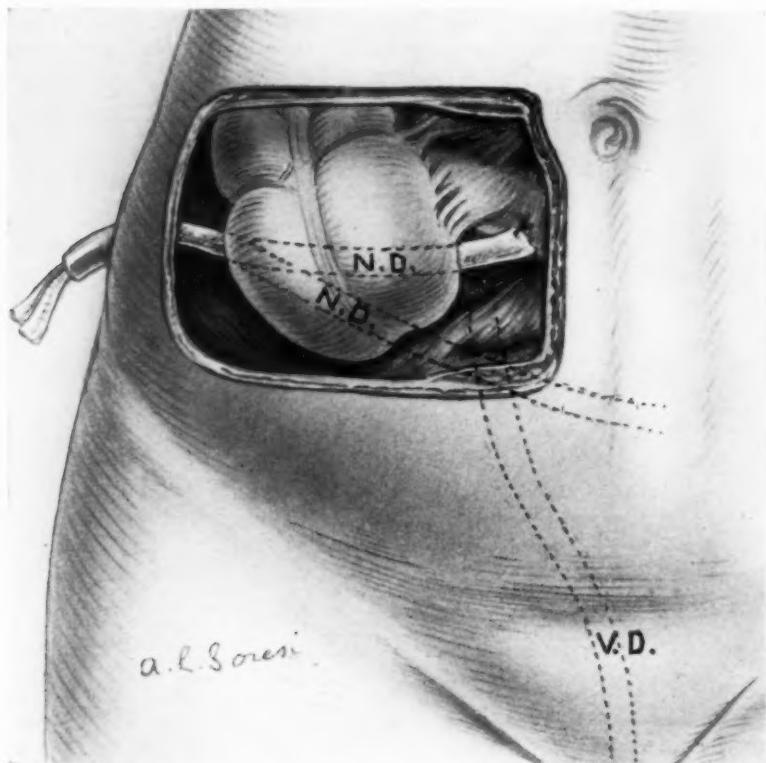


FIG. 26.—Paraffinated strips of gauze put exactly on the spot to be drained and brought out in normal drainage (N. D.) through the rubber tube; in certain cases they may be brought out through the cul-de-sac of Douglas (V. D.). (Note that the drain is held in position by a stitch which, however, should be made with very fine catgut and tied with only one knot). (See Figs. 21-23.)

completely occlude the space between the gauze and the tissues, occlusion that is helped also by the drying of the secretions on the skin around the gauze when the secretion is not abundant; all these drawbacks are eliminated by placing a paraffinated rubber tube in the abdominal wall and having the gauze come out through it (Figs. 25 and 26). Naturally, if two or more collections of pus are to be drained, two or more strips of gauze are used and brought out through a single tube (Fig. 26). Drainages are shortened and finally removed according to circumstances.

*Pararectus Incision and Drainage of Abdominal Wall.*—We advise the

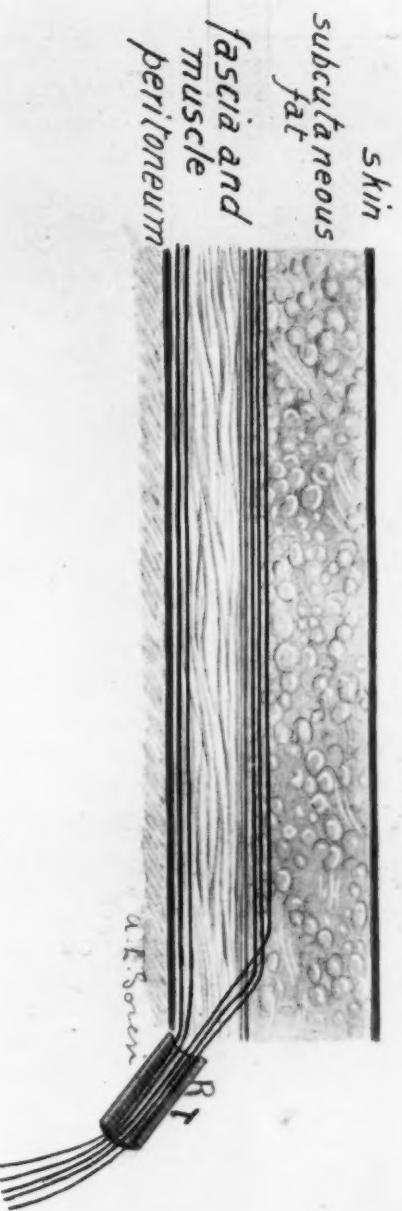


FIG. 27.—Schematic cross-section of drainage of abdominal wall. Paraffinated threads are applied over peritoneum and fascia and brought out through R.T., a paraffinated rubber tube. Note that drainage is accomplished only by gravity, stab wound being in a more dependent position than laparotomy wound (see FIG. 28).

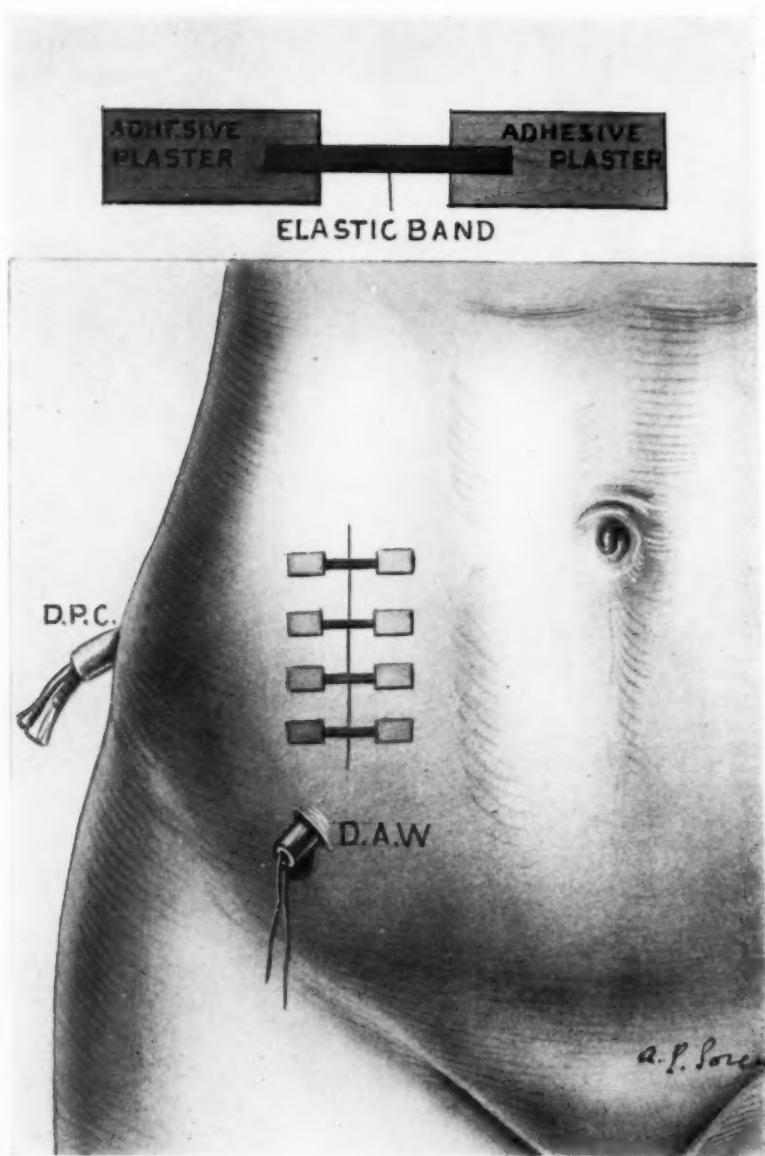


FIG. 28.—Shows abdomen closed and drains applied. Abdominal wall is closed with two rows of sutures, the skin is approximated with elastic bands that give practically a scarless union. D. P. C., drainage of peritoneal cavity; D. A. W., drainage of the abdominal wall; this drainage will prevent post-operative hernia. (See Fig. 27.)

pararectus incision, because it falls on the cæcum, can be extended freely and allows the extraperitoneal removal of the appendix better than any other incision. By following the technic we have advised infective material will very seldom touch the abdominal wall, so that post-operative hernia will be prevented more often than when this technic is not followed.

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We make a longer incision than is usually made, because we believe that a good exposure of the abdominal organs is most essential to good abdominal surgery, and by draining systematically with our paraffine gravity drainage the abdominal wall (Fig. 26) and the elastic closure of the same as shown in Fig. 28, post-operative hernia is practically completely eliminated, even in the most infected cases. The peritoneum is closed in the usual manner and over it are laid two or three heavy threads that have previously been dipped in paraffine and are carried out through a stab wound made anteriorly and outwardly to the lower limit of the skin incision; the muscles and fascia are then sutured and three or four paraffinated threads are laid over the sutured structures and brought out through the same stab wound through which the other threads have been carried out. The stab wound is lined with a small rubber tube previously dipped in melted paraffine, as was done and explained for the stab wound in the flank (Figs. 25 to 28), and all the threads are carried out through it. The skin is not sutured but approximated with elastic bands made of two strips of adhesive plaster and a piece of rubber band; this arrangement insures a better closure of the skin which results in practically an invisible scar and does not favor the dissolution of the fat found in the abdominal wall. We close all laparotomy wounds in this manner, because the drainage and the elastic closure insures a primary union even in the infected cases, and this is very important, especially in cases of acute appendicitis, because the laparotomy wound has a great tendency to suppurate, even in clean cases.

*Interval Cases.*—In the interval cases appendectomy is performed following the same technic that we use in acute cases, except that when the appendix is free and visible we catch its tip with a soft sponge-holder covered with rubber, as shown in Fig. 29, and the removal of the appendix is the first instead of the last step.

*Disposal of the Stump at the Base of the Appendix.*—The importance of the problems relating to the disposal of the base of the appendix is due to these facts: septic material can be poured into the abdominal cavity from the opening existing between the appendix and the cæcum; the blood supply to the whole appendix comes from the blood-vessels at the base of the appendix, except in women, when occasionally a supplementary blood supply comes from the broad ligament. These facts emphasize the absolute necessity of properly disposing of the stump of the base of the appendix; if this is not done the septic material coming from the cæcum will either cause a general fatal peritonitis, or in the lucky cases a fecal fistula; fatal hemorrhage might result if haemostasis of the blood-vessels of the base of the appendix is not properly insured. These facts show plainly that the surgeon must, when possible, close the appendix at its base, and insure perfect haemostasis. Which is the best manner of securing both these desiderata? Obviously, if the technic we have advised is followed, the inversion of the stump of the base of the

appendix being the first step, this step will be properly attended to in all cases; if the tip of the appendix is looked for as the first step, the proper disposal of the stump of the base of the appendix might not be possible, as explained above. We have, however, to justify why the inversion of

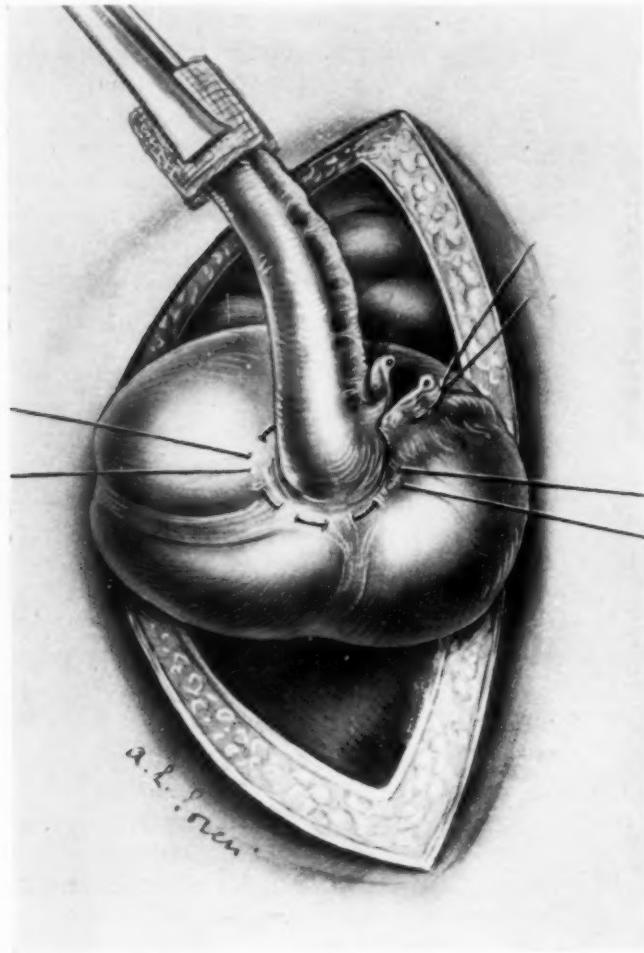


FIG. 29.—Manner of removing appendix in interval cases when no adhesions are present. All the other steps are illustrated in Figs. 15-19.

the stump of the base of the appendix, as we advise, is better than ligature and inversion or simple ligature.

*Inversion of the Stump of the Base of the Appendix Without Tying It.*—Following the technic we have described the thread enters the mucosa. Is it safe and indispensable to do so? Yes; the thread can safely enter the mucosa, as there is no reason to fear a more severe infection from the thread if it goes through than if it does not do so, because the whole wall of the gut is already permeated with microorganisms, and anyhow, the

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whole thread will immediately be buried under a deep layer of inverted serosa, which will adhere immediately (Fig. 30B). It is indispensable to penetrate the lumen of the gut, otherwise fatal hemorrhage might ensue, because the blood-vessels of the gut run into the submucosa, and therefore would not be closed if the suture should penetrate only the serosa, as was recommended by Dawbarn.

It is easy and safe to invert the stump of the appendix if our technic

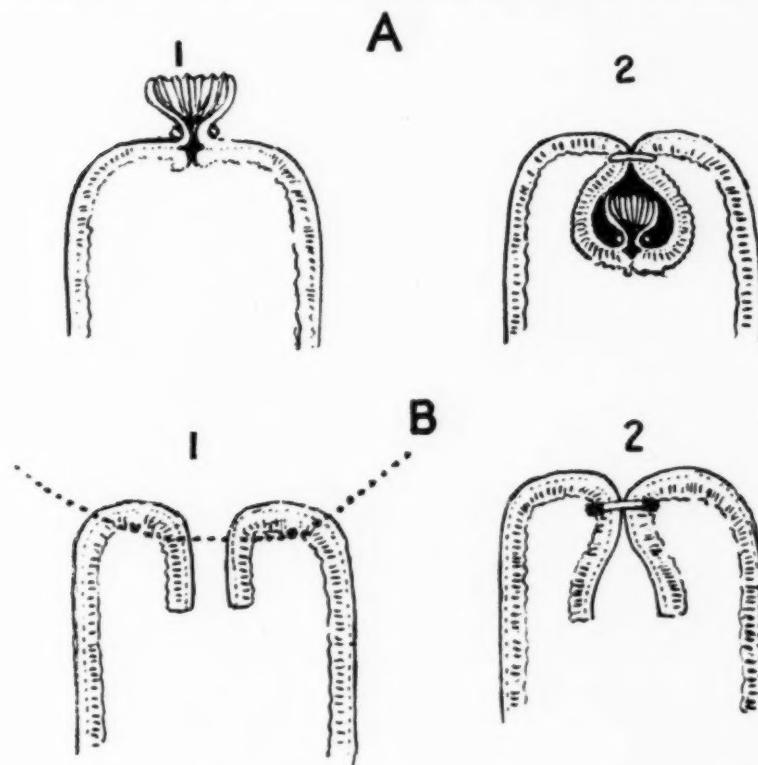


FIG. 30.—Schematic cross-section, showing irrationality of tying the stump of the appendix prior to its inversion. A-1 shows the stump tied; A-2 shows the same stump inverted, with a suture applied over it; note closed cavity formed in A-2 which will be filled with septic material that might burst in the abdominal cavity; note also that when the stump is tied there is no real inversion of the stump but the stump is merely buried between two layers of serosa; inversion can only take place if the stump is inverted without being previously tied, as shown in B. B shows inversion of stump without tying it; note inversion and close approximation of inverted serosas, which will immediately adhere and close base of appendix; note also, that thread enters the lumen B 1 and 2, and is buried in the inverted serosa, when inversion has taken place B, 2.

is followed, even when it would be impossible to do so, when the usual technic is adopted, because the assistant holds up the cæcum by four threads which prevents the escape of any fluid and undesired premature tightening of the purse-string suture before inversion has taken place, as happens when there are only two ends to the purse-string suture, as in the usual technic; also the purse-string suture applied, as we have recommended does not tear the gut.

We never tie the appendix, because we have found that the manner

of inversion we have described gives the best result *quoad vitam* and *quoad functionem*; indeed, by looking at Fig. 30A any one will be convinced that when the appendix is tied and then inverted a closed cavity will be formed that will positively be infected, even if the stump of the appendix has been cauterized, or supposedly disinfected with carbolic acid, iodine, or any other chemical; this closed cavity will increase in size by the secretion of the tissues that are closed in, and set up a reaction of the surrounding tissues, which means formation of adhesions in the favorable cases, or rupture and consequent general peritoneal infection or formation of fecal fistula in the less fortunate cases. If a ligature is put around the



FIG. 31.—Shows stump of appendix simply tied. Note mucosa in direct contact with peritoneum and how easily an inflamed and brittle appendix can be cut by the thread; note also, that stump beyond ligature must be absorbed and therefore will be the cause and centre of adhesions.

appendix without inversion another dangerous condition may arise, the thread is very likely to cut through when applied on very inflamed and brittle appendices, so giving rise to possible general peritonitis or fecal fistula; the base of the appendix must slough off, because being tied (Fig. 31) it is deprived of its blood supply, its mucosa is external; all this means that it will set up some infection and later it has to be absorbed by connective tissue of new formation; which means presence of more or less scar tissue later, which means adhesions which might be more or less troublesome, but the formation of which should be prevented in all cases in order to conform to good surgical principles.

The comfort of the patient is of great importance, and we adopt as an external dressing an elastic abdominal belt without any bones (Fig. 32), so that the whole abdomen is kept gently constricted, without, however,

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undue pressure. The elastic belt makes not only the most comfortable dressing, because it holds comfortably the abdominal organs, but it is also the most convenient, because it helps in preventing post-operative hernia and can be released and replaced without inconvenience to the

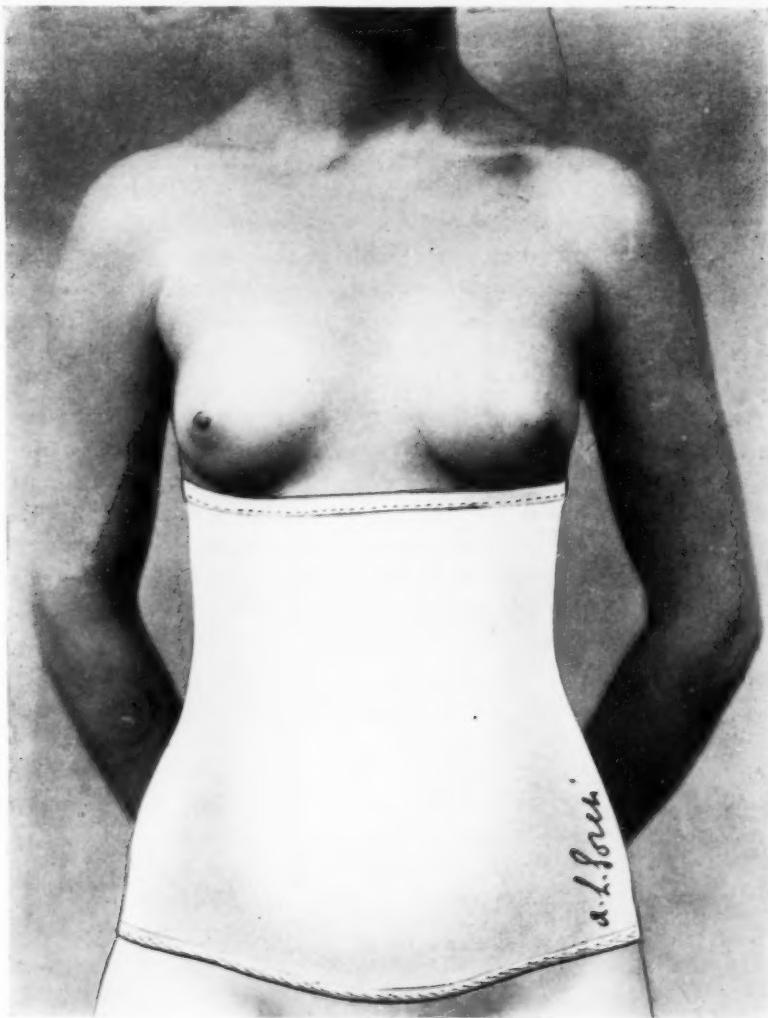


FIG. 32.—Showing how elastic abdominal belt without bones is applied as external dressing

patient. In order to prevent the necessity of using pads and irritation to the peritoneal organs by the iodine commonly used to prepare the skin, we prepare the skin by cleansing it with ether and then cover it with a solution of rubber and ether, that does not come off and will make the use of pads unnecessary, as described in another paper.<sup>1</sup>

<sup>1</sup> A. L. Soresi: Preparation of the Skin for Operation with Solution of Rubber and Ether Instead of Tincture of Iodine. ANNALS OF SURGERY, January, 1920, p. 100.

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*Conclusions.*—In cases of acute appendicitis the patient's life might be in grave danger whether he is operated or not; the surgeon, therefore, must deal with the case so that he follows the principle of *primum non nocere*; then he has to think that his work must be done in such a manner that the operation will give the best results *quoad vitam* and *quoad functionem*. We believe that the special points of the technic that we advise in all acute cases; ether-rubber preparation of the skin; pararectus incision; freeing of only the external portion of the cæcum; raising up the cæcum, so as to expose the base of the appendix, immediately severing the appendix close to its base and inverting it; then following the distal portion of the appendix and removing as much of it as possible; paraffine gravity drainage when pus is present; closure of the abdominal wound in all cases; paraffine gravity drainage of the abdominal wall; elastic closure of the skin; the application of an elastic belt as an external dressing; answer all the desiderata. Indeed, life is saved more often if this technic is followed, and we have had striking proofs of this fact in several almost desperate cases, which are not referred to for brevity's sake, than if this technic is not followed; because no one can be sure of the position and condition of the appendix in all cases, and the technic recommended is ideal for all cases, because it prevents the spreading of infection in all cases and does not lower the resistance of the peritoneal organs, and does positively drain out safely any secretions that should be drained out. *Quoad functionem* it prevents the formation of fecal fistulæ, of dangerous post-operative adhesions, of post-operative hernia; it allows a maximum of comfort to the patient.

## FRACTURES OF THE PELVIS\*

WITH A REPORT OF TWENTY-FIVE CASES

By WILLIAM JOHN RYAN, M.D.  
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FRACTURE of the pelvis, until very recently, had not received the consideration that is due such a serious injury. It is a much more common result of violence than is generally supposed. Therefore, it is with these thoughts in mind that this series of cases is presented.

The first extensive report based on the findings in the literature was by Quain<sup>1</sup> in July, 1916. He reviewed one hundred and twenty-six cases and reported one of his own. His reported mortality previous to 1890 was 86.7 per cent.; since then it was 48 per cent., and since 1905 it is 38 per cent. Since then single cases have been reported by Hawkes,<sup>2</sup> Moorhead,<sup>3</sup> Ross,<sup>4</sup> Klotz,<sup>5</sup> Angiovene,<sup>11</sup> and Dunott.<sup>12</sup> And Gazzotti<sup>6</sup> reports two cases with a description and photographs of an apparatus for their treatment. Mitchell<sup>7</sup> in 1917 read a very exhaustive article on the diagnosis and treatment of fracture of the pelvis. While the author's paper was in the stage of preparation, Mengel<sup>8</sup> presented his very excellent paper embodying sixty-nine cases before the Pennsylvania State Medical Society last September. These papers totalled 202 cases, and to this number we are privileged to add 21 cases. They were treated in the surgical wards of the University, Polyclinic, and St. Agnes Hospitals on the services of Doctors Frazier, Brinkmann, and Muller, to whom I am indebted for the privilege of reporting them.

Humphrey<sup>9</sup> describes the ring of the pelvis as heart-shaped, and calls attention to the wide arch with a flattened centre of the upper or posterior half, and the greater curve with flattening at the ilio-pectineal regions of the lower or anterior half. It results from this configuration that the pelvic ring is weakest at five points, *viz.*, at or a little external to sacro-iliac synchondroses; at the symphysis pubis; and midway between the symphysis and the acetabula.

In studying the clinical effects of fracture of the pelvis it is helpful to consider it with reference to its various functions:

As interposed between the vertebral column and the lower extremity as a weight bearer.

As a means of providing for motion of the trunk on the lower limbs, and of affording some points of attachment for the muscles governing that motion.

As a bony protection for the abdominal and pelvic viscera. When viewed as a bony ring between the spinal column and the femora, the pelvis is made up of two main arches, one in use when standing and one

\* Read before the Philadelphia Academy of Surgery, December 1, 1919.

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when sitting. The sacrum is the point of union or keystone of both these arches. One extends from the acetabulum through the thick bony ilium, through the upper third of the ilio-pectineal line to the sacrum and is called the sacro-femoral arch. The other extends from the tuberosity of the ischium through the posterior edge of the acetabulum to the same point and is called the ischirosacral arch. These are the essential weight-carrying portions of the pelvis.

Morris<sup>10</sup> calls attention to the mechanics of the remaining portions of the pelvis in this way: When much strength is essential in an arch it is often prolonged in a ring to form a counter arch, *i.e.*, the ends of the arch are tied together so as to prevent them from starting outward. Therefore, a portion of any weight carried by an arch is distributed to the centre of the counter arch. Now in the pelvis the body and horizontal rami of the pubis form the counter arch of the sacro-femoral arch, and the union of the rami of the pubes and ischii the tie of the ischirosacral. The ties of both arches are united in front at the symphysis which like the sacrum is common to both arches. Therefore, it can be easily understood why any severe direct violence applied to the pelvis will result in fracture of the horizontal or descending rami of the pubis, the rami of the ischium, and of the ilia external to the sacro-iliac joint.

In this series of 21 cases there were seven deaths, a mortality of 33.3 per cent.

The youngest patient was six and the oldest sixty-five. All had been subject to severe injury.

Twelve cases were simple fractures, that is, without visceral complication, though three of them were complicated by fractures of other bones. In five cases there was a rupture of the bladder and in three a rupture of the urethra. One case which died on the operating table had a torn deep epigastric artery in addition to an intra- and extraperitoneal rupture of the bladder. Bloody urine was present in one case without evidence of rupture of the bladder or kidney, due possibly to a contusion of the bladder or kidney. An inguinal abscess developed in one case and an abscess over the right hip and gluteal region in another, both several days after the injury. In one case there was a penetrating fracture of the acetabulum (mention). This would seem to differ from Doctor Estes' statement in discussing Mengel's paper that "When the body of the pubis and ramus of the pubis are broken by direct violence, drainage is almost imperative. It is not simply the rupture of the bladder or urethra; that, of course, makes drainage an absolute necessity. But there is in my experience a very large amount of blood effused in the cellular tissues of the perineum and ischiorectal region, and this blood is nearly always contaminated by colon bacillus or by some slight leakage from the urethra. Almost inevitably there is infection." Fracture of the pubis occurred twelve times in this series and in only one of these did such an infection occur—a gluteal abscess (Case XII). The ilium was involved seven

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times, the body of right ischium once. The anterior superior spine once; the acetabulum once, and both tuber ischi. The patients that died all had other severe injuries.

CASE III.—Aged sixty-five. Rupture of urethra, multiple fractures of the ribs developed nephritis. Died on twenty-sixth day.

CASE IV.—Died in thirty hours. Had a fractured skull, sixth, seventh, eighth ribs, femur, and compound fracture both bones leg.

CASE VIII.—Ruptured bladder and urethra; signs of internal hemorrhage; profound shock. Died in two hours.

CASE X.—Fractured skull and evidence of a ruptured bladder. Unconscious on admission. Died in three hours.

CASE XV.—Ruptured bladder. Developed cystitis and general sepsis after operation. Died in six days.

CASE XVII.—Extensive lacerated wounds of the perineum extending up into the abdominal cavity, through the neck of the bladder. Died three hours after admission.

CASE XVIII.—Rupture of bladder, intra- and extraperitoneal. Peritonitis present, torn deep epigastric artery. Died three hours after operation.

*Symptoms and Diagnosis.*—Every case of severe injury in the pelvic region should be looked on with suspicion. The clinical findings should be checked up by X-ray, of course, but there should be no delay in operating if it is indicated.

The most common symptom is pain; felt usually at or near the seat of fracture. It is sometimes described by some patients as "a pain through the pelvis." This pain is increased by pressure inward exerted simultaneously on both hips. I agree with Mengel that crepitus should not be looked for because of the danger of injuring the urethra or bladder if they have not already suffered. Crepitus was noted on our records three times.

Movement of the body causes pain in or near the seat of fracture. I feel that rectal examination should not be made in suspected fracture of the ischium for fear of a sharp edge of bone puncturing the bowel.

The patient should always be catheterized. If bloody urine is withdrawn a given amount of some sterile solution such as boric acid should be injected after the bladder is emptied by catheter and then drawn off again. If the full amount is recovered one can feel reasonably sure that the bladder is not ruptured. In case the catheter cannot pass because of rupture of the urethra, a perineal section should be done and an attempt made to reconstruct the urethra. Drainage should also be provided for. It may be necessary to do a suprapubic for retrograde catheterization.

Should the bladder be ruptured extraperitoneally there will in addition be a swelling and bogginess over the lower abdomen. This, of course, will require incision and proper drainage of the space of Retzius.

If the fragments are exposed at the time of operation and can be

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replaced in proper position without difficulty, it should be done. Otherwise they had best be let alone.

As to treatment of the fracture. If it is a fracture of the ilium with or without sacro-iliac joint involvement, a plaster cast should be applied around the pelvis, cut out in the proper place to allow for attention to bowels and urine.

If the pubis or ischium is involved a wide adhesive swathe should be applied giving access to necessary wound dressings. In either case the patient should be placed on a Bradford frame with the head end resting on the head of the bed and the foot end on the mattress against the foot of the bed. This will permit attention being given him without disturbing his position.

Of the cases that recovered eleven were traced at the end of a year or more.

Seven were in absolutely normal condition.

One had normal function but had occasional pains in the region of the sacrum.

One had a limp due to shortening in a fractured limb which fracture was sustained at the same time as the pelvic injury.

Another who had a possible rupture of the urethra had some delay in starting urination and some dribbling. Examination disclosed an enlarged prostate. He improved under treatment but drifted from observation.

One case had vague pains through the pelvis though examination was negative.

### ABSTRACTS FROM CASE RECORDS

CASE I.—Jas. H., aged twenty-three years, admitted January 23, 1918. Was caught under a falling wagon, which struck him on the right hip and pinned him beneath it. He was unable to walk and complained of pain in both gluteal regions. There was some tenderness over the region of the bladder and pressing both hips together caused pain above the symphysis pubis. Temperature was 99; pulse, 82; and respiration, 22. He was catheterized without difficulty, first few c.c. were bloody, but the remainder was clear. Bladder was emptied and eight ounces of sterile boric acid solution injected. Full amount was withdrawn, showing no rupture of the bladder. An adhesive swathe was applied to the pelvis and the patient placed on a Bradford. A little blood continued to leak from the urethra, so a permanent catheter was inserted and the bladder irrigated daily with saturated solution of boric acid. This man was a persistent kicker and did not like or appreciate anything that was done for him. February 13 a plaster cast was applied and kept on until his discharge February 25, one year after injury. He had no symptoms, walked without a limp, and voided freely and without pain.

CASE II.—J. P., admitted October 30, 1914. Discharged December 15, 1914. He was knocked down and run over by an automobile. On admission his temperature was normal. Pulse 100, and respiration

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tion 26. He complained of great pain in right hip. Right leg was rotated externally and abducted. Soon after admission he voided clear urine. There was considerable ecchymosis about the right inguinal region. Otherwise physical examination was negative. X-ray showed a linear fracture of the right ilium extending into the acetabulum, and epiphysial separation of the right ischium. A plaster cast was applied to the pelvis and extension to the right leg with sand-bags on either side. He was then placed on a Bradford frame. Five days after this his temperature began to rise and inspection disclosed a large abscess in the right inguinal region. This was incised and drained. December 10 the cast was removed and on the 15th he was discharged. At this time there was some limitation of motion in the right hip. The inguinal wound was healed.

One year later there was no deformity, he walked without a limp, and manipulations showed no limitation of motion in the right hip.

CASE III.—J. B., aged sixty-five years, admitted November 25, 1917. Died December 21, 1917. Was in an automobile which was run into by a street car. Pain and loss of power in the left leg, and pain in the left hip. Examination showed an abrasion of scalp. Fracture of third and fourth ribs on left side at the costochondral junction. Left ilium was freely movable, and crepitation could be elicited over the symphysis. Temperature was 97°; pulse, 68; and respiration, 20. A diagnosis of fracture of the pelvis with rupture of the bladder was made. X-ray showed a fracture of the descending ramus of the left pubis with considerable separation and a fracture through the body of the left ilium.

November 25: Operation by Doctor Muller. Under spinal anaesthesia abdomen opened, but no intraperitoneal rupture of the bladder was found. The preperitoneal tissues were very much infiltrated with blood. Investigation in the space of Retzius showed the bone to be bare and a fracture of the descending ramus of the left pubis with about 1 to 2 inches separation of the fragments. A large amount of blood was evacuated and it was thought that the urethra was ruptured near the neck of the bladder. Rubber-tube drainage was inserted and the wound closed, with the intention later to do a perineal repair, perhaps accompanied by a suprapubic incision. The man was in bad shape all through the operation; caffeine and strychnine were given hypodermically and saline intravenously. Before closing the peritoneum 20 drops of adrenalin were introduced following the directions of Porter for the treatment of shock. He did fairly well following this operation, but continued to drain urine from the abdominal wound. On December 13 an unsuccessful attempt was made to introduce a tube in the bladder with a purse string, so a urethral catheter was connected with the drainage tube in the hope that permanent drainage would be obtained.

Urine examination showed amber, 1030; heavy cloud of albumin, no sugar. Many light and dark granular casts.

This man did very badly after the second operation, gradually sinking into a state of coma from which he never recovered.

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CASE IV.—Mrs. H., aged forty-seven years, admitted February 22, 1917, died February 23, 1917. She was knocked down and dragged by a street car. On admission she was in a very desperate condition. She had fractures of the right ilium, and sixth, seventh, and eighth ribs on the right side, depressed fracture of the skull in the right frontal region, fracture upper third of the right femur, compound comminuted fracture both bones of right leg in lower third, and contusions of the entire body. She never recovered from her shock and died about thirty hours after admission.

CASE V.—J. P., admitted January 7, discharged January 22. Crushed between a crane and some heavy object. Chief complaint was pain in the region of the right hip. General condition was good. Redness and swelling over right hip, tenderness on pressure over the horizontal ramus of the right pubis. Movements of both hips painless; with finger in the rectum, pressure against the right descending ramus elicited tenderness. No blood in the urine or faeces. X-ray showed an impacted fracture of the horizontal and descending rami of the right pubis. There was no pain when lying perfectly quiet. A wide adhesive swathe was applied and the patient placed on a Bradford frame. He was discharged with his adhesive swathe in place and a belt prescribed. One year after he had no symptoms and walked without a limp.

CASE VI.—B. T., aged thirty-nine years, admitted March 25, discharged April 22. Fell from the platform of a moving train and crashed into a fence. Admitted one hour after the accident.

Pain in region of left hip. Examination showed: Fracture nasal bone, abrasion and contusion of chest, tenderness in region of left anterior superior spine. Catheterized specimen showed no blood. X-ray showed a fracture of the left anterior superior spine and a split fracture of the left ilium vertically downward two and one-half inches from the crest of the ilium.

A plaster case was applied to the pelvis and he was placed on a Bradford frame. Case was removed three and one-half weeks later and he was discharged in four weeks. At this time he had no pain or tenderness over seats of fracture, but he had some difficulty in completely extending the thigh on the trunk (left). One and a half years later he was without any apparent deformity or functional abnormality.

CASE VII.—M. P., aged thirty-one years, admitted November 30, discharged December 10. This case was most interesting because it disclosed a deformity due to a failure to diagnose the condition at the time of the accident.

C. C. Inability to walk without a support and shortening and weakness of the left leg.

He was a miner, and one year before, while lying on his side, a mass of slate fell and struck him on the left hip. He was treated in the local hospital for ten weeks for a fracture of the left femur. Had on a fracture box and extension. After his discharge he was unable to walk without a support. Three months ago he was again put to bed with extension but with no improvement. When he was

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discharged after his first time in the hospital he complained of a numbness and coldness in the left foot. This has persisted up to the present time.

Examination disclosed a slight flexion and external rotation of the left thigh. Shortening of an inch and a half. When the leg is fully extended there is marked lordosis. There appears to be some ankylosis of the hip-joint. There is considerable atrophy of the entire left leg and thigh. Both knee jerks exaggerated. Area of greatly diminished sensation over the outer side of dorsum of left foot. And all the toes show distinct sensory impairment. Urine shows specific gravity 1026; no albumin, many hyaline, and light and dark granular casts. Neurological condition thought by the neurologist to be due to some injury of the spinal cord at the time of the accident. X-ray shows a penetrating fracture of the acetabular ring with the head of the femur jammed through.

CASE VIII.—E. S., aged twenty-nine years, admitted June 29, and died the same day. The steering wheel of a truck broke and it plunged through a bridge railing to railroad tracks 75 feet below, carrying the patient with it. On admission he was in a state of shock, but was conscious. There was some tenderness in the right hypochondrium and in the right costovertebral angle. Much swelling in the left inguinal region, and greatly abnormal mobility and crepitus in both ilia. In attempting to catheterize resistance was felt after passing into the perineum, and a few drops of blood flowed out. He died before operation was performed. A diagnosis of ruptured viscera with internal hemorrhage was made.

CASE IX.—A. S., aged thirty-eight years, admitted April 8, discharged April 22. C. C. Pain over sacral region and weakness of the right leg. March 24 he was thrown from a train to the roadbed and struck a rail in a sitting posture. He was taken to a hospital where he remained several days. Was admitted here through the surgical dispensary. He had no symptoms except those mentioned above. X-ray showed a fracture of the descending ramus of the right pubis without displacement. An adhesive swathe was applied to his pelvis and he was placed on a Bradford frame. At the end of two weeks he had no pain and his right leg was apparently normal.

One year later he had perfectly normal function in both legs, but complained of more or less pain over the sacrum in damp weather.

CASE X.—J. A., admitted November 1, and died the same day. He was admitted in an unconscious condition with a history of having been swept from the top of a train by a bridge. He had a large haematoma in the occipital region, was bleeding from the nose and ears and urethra. All reflexes were absent. There was some mobility over the right symphysis and a sense of bogginess just above the symphysis. He died three hours after admission. A diagnosis of fracture of the right pubis with extraperitoneal rupture of the bladder was made; also a fracture of skull.

CASE XI.—J. A., aged thirty-eight, admitted October 12, discharged April 2. Fell 35 feet when a scaffold on which he was working

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collapsed. Examination shows a punctured wound of the left heel, crepitus in left heel and considerable tenderness over lumbosacral region. There was no blood in urine. Chief complaint pain in back and in perineum. X-ray showed a fracture of the horizontal ramus of the left pubis and fracture of the left os calcis and left astragalus. He was incontinent of urine and a permanent catheter was inserted. An adhesive swathe was placed about his pelvis. The incontinence of urine persisted and he also lost control of his anal sphincter. His temperature began to rise and a yellow discharge from his penis caused considerable discomfort. October 29 a suprapubic cystotomy was done and considerable pus evacuated from his bladder. After this he felt better and his temperature dropped to normal.

November 17: Was still unable to void, so the suprapubic drain was allowed to remain in. Began irrigations of the bladder with boric acid, washing out considerable gravel and pus. He regained control of his anal sphincter.

January 1: The urine was clear and he was allowed out of bed; he walked fairly well. The suprapubic opening was still draining. February 10: Lost control of his anal sphincter again. Became very much discouraged.

February 23: Examination showed the urethra to contain many false passages, one of which communicated with the scrotum.

At this time he insisted on going home. Refused any further treatment whatever.

Unfortunately, this man had moved and we were unable to trace him to his new address.

CASE XII.—E. P., aged sixteen years, student, admitted February 26, discharged April 26. She was struck by a railroad train and was unconscious for two hours. There were no signs of a fracture of the skull. She could not sit up because of excessive pain within the pelvis. There was a compound fracture of both bones of the right leg in the lower third. A large bruise on the right hip. Measuring from right anterior superior spine to right interior mandibles was 3 to 4 inches shorter than the left side. The bases of Bryant's triangles were equal on both sides. There was no pain on moving the hips, but there was considerable pain on pressing both hips toward the midline. There was a fracture of the ninth, tenth, and eleventh ribs on right side. Tenderness over the left ulna about two inches below the olecranon. Urine was voided clear.

X-ray showed a subperiosteal fracture of the left ulna in upper third. Compound comminuted fracture of both bones right leg lower third. Fracture of horizontal ramus of both pubes with slight displacement.

The opening on the leg at seat of fracture was closed by suture and healed kindly.

March 6: Tibia was plated.

March 12: Temperature rose to 105°, and examination showed tenderness and fluctuation over right trochanter. Investigation with needle showed pus; streptococcus pyogenes.

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Exploratory laparotomy under N. O. anaesthesia and eucaine. Right rectus incision. Abdomen negative. Appendix removed. Incision in right hip between trochanter and crest of ilium, large collection of reddish fluid evacuated which had dissected its way upward and downward. It was not purulent in appearance and was probably a large retroperitoneal haematomata which got out by way of the lymphatics.

March 27: A large abscess developed in right gluteal region. It was incised and drained.

April she was discharged with all wounds healing by granulation. There was a cast on her right leg. There was  $\frac{5}{8}$  inch shortening in the right leg because of little callus formation at seat of fracture. All movements in region of right hip were normal.

Two years from the date of her discharge she was able, with the aid of an extra thick heel, to walk with almost no limp.

CASE XIII.—J. H., aged fifty-four, admitted July 14, discharged August 21. He had fallen from a scaffold and landed on his right hip. He had no cough or dyspnea, nor did he complain of any pain in his chest. Chief complaint was pain in right hip and right groin. Could not void urine. Physical examination of his chest and abdomen was negative. He was perfectly conscious. There was quite an extensive bruise on right hip and his scrotum was swollen and ecchymotic. Catheterizing him, 200 c.c. of urine were withdrawn, which was very bloody.

A permanent catheter was placed in his bladder with a little difficulty and an adhesive swathe about his pelvis. He was placed on a Bradford frame. Ten days later the catheter was removed from his bladder and he was able to void thereafter without trouble.

He was discharged with no abnormal symptoms.

Two years after his discharge he could walk without any difficulty. But he complained of dribbling of urine for a short while after voiding. His prostate was considerably enlarged. Light massage and hot sitz-bath improved this condition, but he disappeared from observation before gaining any more headway.

CASE XIV.—M. K., aged forty-three, admitted January 11, discharged March 19. Chief complaint pain in left hip and in left side of abdomen. He was squeezed between two motor trucks which collided. He was conscious on admission; temperature, pulse, and respiration were normal. There was a severe contusion and abrasion over the crest of the left ilium. He voided clear urine and 8 ounces of boric acid solution injected into bladder was entirely recovered. X-ray showed a linear fracture of the left ilium extending from one inch behind the anterior superior spine downward to within one inch of the acetabulum.

A plaster cast was applied to his pelvis and he was placed on a Bradford frame.

When discharged he was able to walk without a limp and complained of no pain in the region of the fracture.

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He returned to his former occupation of laborer and was able to do as much as before his injury.

One year later he was without pain and had no deformity.

CASE XV.—W. S., aged forty-five years, admitted August 15, died August 21. Chief complaint severe pain through the pelvis. In state of shock. He was knocked down by an automobile which ran over his lower abdomen.

He was tender over the lower abdomen, there was a sense of bogginess just above the symphysis; severe contusion of the back in the lumbar region; blood was dripping from his penis. He was catheterized and only one-half ounce of urine was obtained. Eight ounces of boric acid solution was injected into his bladder and only half of it returned. Therefore, a diagnosis of ruptured bladder was made.

He was given an intravenous infusion of saline and under ether a suprapubic incision was made. There was no intraperitoneal rupture of the bladder found, so the space of Retzius was investigated. There was found a collection of blood and urine and the fragments of a fractured right descending ramus were found. A couple of small loose pieces were removed and a rubber tube inserted for drainage. A suprapubic drain was placed in the bladder and a permanent catheter was placed in the urethra. He did very poorly after the operation; ran a continuously high temperature and was very flighty. Urine showed a heavy cloud of albumin and many granular casts. Two days after operation he began to drain pus from the opening in the space of Retzius. He died on the sixth day after admission from general sepsis.

CASE XVI.—Mrs. E. F., aged forty-one years, admitted September 14, discharged October 22. She was knocked down and rolled beneath a street car. She complained of great pain in both hips. Her temperature was 97°; pulse, 68; and respiration, 18. She had general contusions all over her body and was so sensitive that examination was very difficult. Pressure on both hips caused considerable pain in symphysis region, and she was very tender over both tuber ischii. Eight ounces of boric acid injected into bladder was fully recovered.

X-ray showed a fracture of the descending ramus of the right pubis and a fracture of both tuber ischii.

A plaster cast was applied September 20 and removed October 20. She was discharged October 22, walking normally, but complained of more or less pain on sitting down.

Two years after she was in good health and had no symptoms resulting from her accident.

CASE XVII.—A sailor on *U. S. S. Missouri*, age about twenty-five, was admitted 5.45 P.M. in state of profound shock, and died at 8.15 P.M. He had been dragged by a street car. The perineum was the seat of extensive lacerated wounds, there were abrasions of both knees and an abrasion involving the entire front of the left thigh and the inner side of the left leg. All wounds were bleeding pro-

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fusely; both ilia were freely movable and there was marked depression on both horizontal rami.

The wounds were packed with sterile gauze and he was given 600 c.c. of normal salt solution intravenously with 30 minims of adrenalin. He never rallied from his shock. Died about three hours after admission.

CASE XVIII.—G. F., aged thirty-seven years, admitted January 11, and died same day about eight hours later. Temperature on admission was 96°; pulse, 80; and respiration, 32. Injured in collision of two motor trucks. Abdomen was very rigid and his urine was bloody, only a few c.c. being obtained by catheter. Of 8 ounces of boric acid solution injected into the bladder only 2 ounces were recovered.

There was a depression over the horizontal ramus of the right pubis. He was given an intravenous injection of salt solution and taken to the operating room. A suprapubic incision was made; the abdominal wall was greatly infiltrated with blood from torn deep epigastric artery on right side. There was an intra- and an extra-peritoneal rupture of the bladder. Peritonitis was present. The peritoneal cavity, the bladder, and the space of Retzius were drained with rubber tubing and the abdomen closed with through-and-through suture of silkworm gut. He never fully recovered from his anaesthetic, but died about three hours after operation.

CASE XIX.—T. McF., aged twenty-one, admitted April 19, discharged May 24. He was caught between a falling timber and the side of a freight car. On admission he complained of severe pain in the right side and the right iliac crest. His general condition was good; no evidence of a rupture of the bladder or urethra was found. A diagnosis of fracture of the right ilium was made and confirmed by X-ray. The fracture beginning 2 inches behind the anterior superior spine running down toward the acetabulum for about 3 inches.

An adhesive swathe was applied and he was placed on a Bradford frame. He made an uneventful recovery and was discharged walking normally and without any pain.

CASE XX.—F. F., aged thirty-six, admitted May 23, discharged July 10. He had been run down by a light motor car which passed over his lower abdomen.

He was in good general condition. There were abrasions of both hips and a swelling over the symphysis. He complained of some pain in right groin, especially when the hips were pressed together. He voided bloody urine. Eight ounces of boric acid solution was injected into the bladder and only 5 ounces was recovered.

A diagnosis of fracture of the right pubis with ruptured bladder was made and he was operated on immediately.

There was found a rupture of the bladder in the space of Retzius. This space was filled with clots and urine came from the wound in the bladder. The bladder wound was sutured and a rubber tube drain placed in the space of Retzius. He made an uneventful recovery.

X-ray later disclosed a fracture of the descending ramus of the

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right pubis. We were unable to locate this man at the end of a year and a half.

CASE XXI.—F. T., aged fifty-four, admitted February 14, discharged March 25. He was struck on the side by a piece of falling timber. There was a large abrasion over the right hip; pressure on the right crest elicited exquisite tenderness. His general condition was very good; X-ray showed a fracture of the right ilium extending from the anterior superior spine downward and backward for a distance of 3 inches.

An adhesive swathe was placed around his pelvis. He was discharged in normal condition.

One year later he was without pain except in damp weather. He had no limitation of motion nor interference with locomotion.

CASE XXII.—T. T., a colored girl. Knocked down and dragged by a trolley car.

On admission she was in fairly good condition. There was a contusion of the left leg and hip; fracture of the left humerus. She was very tender over both ischii and over the symphysis.

X-ray showed a fracture of the left humerus, fracture of the left ischium, and fracture of the horizontal and descending rami of the left pubis.

She was placed on a Bradford frame and an adhesive swathe placed about her pelvis. There were no complications and she made an excellent recovery. On discharge she was able to walk without support but with a slight limp, favoring the left leg.

CASE XXIII.—T. L., white, a teamster. Admitted August 25, discharged October 10.

Received in accident ward slightly under the influence of alcohol. Gave a history of having been thrown from a wagon. He maintained that the wagon passed over his pelvis. On examination he was very apprehensive and very nervous. There were no signs of any grave injury. There were no evidences of a fracture of the pelvis or lower extremity. He voided urine freely and it contained no blood. He was admitted to the ward and put to bed.

The next day he complained that he had considerable pain in his left groin on walking.

X-ray disclosed a fracture of the horizontal ramus of the left pubis without displacement.

An adhesive swathe was applied and he was placed on a Bradford frame.

CASE XXIV.—W. L., aged forty-five, admitted January 30, discharged March 25. On admission temperature, 97.3°; pulse, 68; respiration, 20. While helping to move a heavy iron tub the hoisting chains broke and it fell, striking him in the back.

Abdomen was slightly distended and rigid, but not tender. Extremely tender over the left great trochanter and over the symphysis. There was a fracture of the middle of the shaft of the left femur with  $1\frac{3}{4}$  inches of shortening.

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He was put to bed with extension on the fractured leg and anti-shock measures instituted.

Next day X-ray showed a fracture of the left acetabular ring, a fracture of the horizontal ramus of the left pubis, and a fracture of the middle of the shaft of the left femur.

No urinary symptoms arose.

February 15: There was no shortening.

He was discharged walking on crutches.

CASE XXV.—H. B., aged twelve years, admitted May 12, discharged May 22. Knocked down by an automobile which ran over his right hip. On admission he was somewhat shocked. Temperature, 97°; pulse, 76; respiration, 20.

Could not stand and complained of great pain in the right iliac crest. Right thigh could be moved freely but with considerable pain. There were no urinary symptoms.

X-ray showed a linear fracture of the ilium extending from the crest downward toward the acetabulum. The lower half of the line of fracture split in two.

NOTE.—Between the time this paper was read and its being sent to the publisher, Cases XXII, XXIII, XXIV, and XXV were discovered in the records. This will bring the mortality down to 28 per cent., and add the following to the bones that were the seat of fracture: Ilium, 1; acetabulum, 1; left pubis, 3; left ischium, 1.

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## USE OF FREE SKIN GRAFTS TO REPLACE LOSS OF MUCOUS MEMBRANE OF MOUTH AND NOSE\*

BY GEORGE M. DORRANCE, M.D.  
OF PHILADELPHIA, PA.

FREE skin grafting, particularly in the replacement of the mucous membrane of the mouth, received during the late war an impetus which has carried it out of the class of operations which usually fail, and what may even be termed the experimental stage, and established it as a definite procedure from which an almost positive assurance of success can be given.

Before proceeding to describe a new method, it is always advisable to review the methods that have been used, past and present:

1. Free Ollier-Thiersch grafts have formerly been tried in the mouth, but have usually failed.

2. Mucous membrane flaps from other parts of the mouth. This is the method of choice, when there is sufficient membrane to spare, and there is no danger of producing contracture or shortening of the mucous membrane at the place from which the flap is taken.

3. The taking of a flap from the skin surface to replace oral mucous membrane is a difficult procedure, causing a large amount of scar tissue, and only too frequently the flap will be hair bearing, which is a very disagreeable complication. However, it has a decided place in closing a large defect or in making an entire lip.

4. *The Free Ollier-Thiersch Graft, Held in Place Under Pressure.*—To Esser (*ANNALS OF SURGERY*, Philadelphia, 1917, lxv, 297) belongs the credit for introducing the buried free skin graft. In seeking a means for applying Thiersch grafts evenly and maintaining them immovable under equal pressure on the wound for several days, Esser conceived the idea of stretching the skin graft on an impression of the wound made in dental modelling composition, inserting this in the hollow of the wound, and suturing the edges of the wound over it. It is interesting to note the evolution of the present operation from this. To correct certain deformities or contractures in which there was a loss of mucous membrane, Esser incised the skin over the contracture, and dissected down to the contracture but not into the mouth. Of this cavity he made an impression in modelling compound. Upon the impression he placed a Thiersch skin graft, with its raw surface out, and then introduced it into the cavity and sutured the skin edges over the compound. Ten days later he incised the scar tissue from within the mouth, and removed the compound, leaving the graft in place, lining the cavity which was then con-

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\* Read before the Philadelphia Academy of Surgery, December 1, 1919.



FIG. 1.



FIG. 3.



FIG. 6.



FIG. 2.



FIG. 1



FIG. 7.

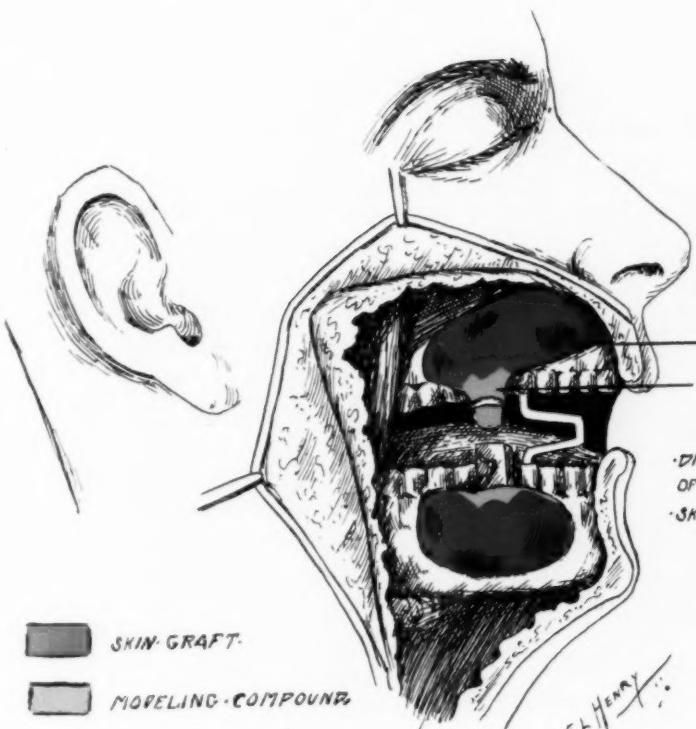


FIG. 5.



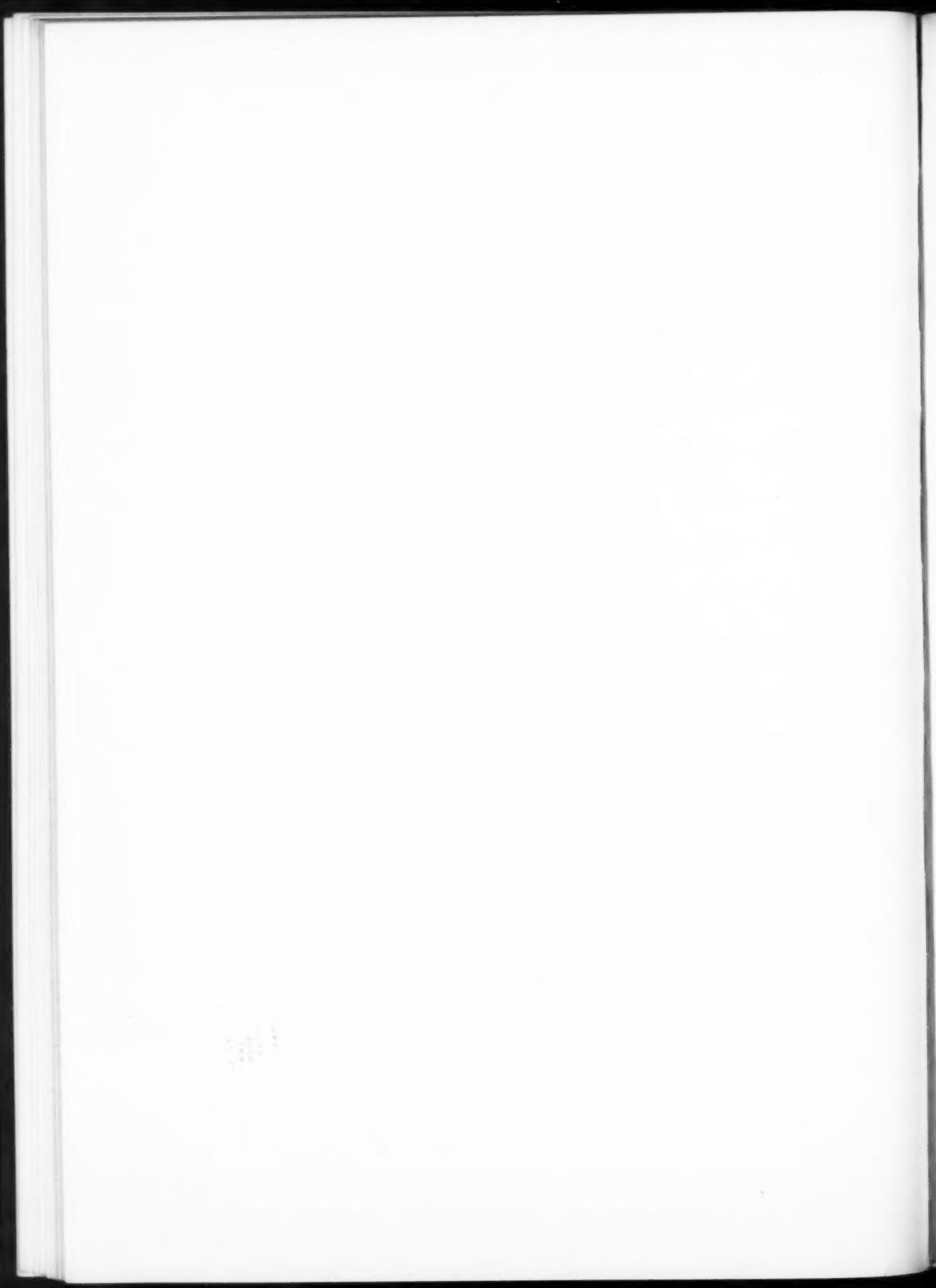
FIG. 8.



FIG. 9.



FIG. II.



## FREE SKIN GRAFTS IN MOUTH AND NOSE

tinuous with the mouth cavity. Now why did the graft take? Let us try to give the reasons why grafts on the skin surface often fail: (1) An accumulation of serum under the graft. (2) Formation of crusts around the grafts. (3) The grafts are not kept warm and at uniform temperature. (4) They are frequently moved or pulled off in changing the dressing or when the dressings are moved by muscular action. The success of the modelling compound support depends upon the correction of all these defects. In general skin grafting, we have found a greater number of takes could be obtained by covering the grafts with an accurately fitting layer of modelling compound. This is brought about by taking an accurate impression of the area and one inch of the surrounding skin in modelling compound, before applying the grafts. Then the grafts are applied and covered by the modelling compound. This method was first seen by me at the Queen's Hospital, Sidcup, England, on Major Gillies' service. The modelling compound employed in this work is the ordinary impression material used by the dentists, which is readily softened in hot water.

Major Waldron, R.A.M.C. (Canadian Forces), at the Queen's Hospital, Sidcup, modified Esser's procedure by dividing the scar tissue through the mouth instead of externally, making a cavity into which he introduced an accurate impression of modelling compound covered with a Thiersch graft. He then sutured the incision in the mucous membrane. The compound usually remained in place for several days, then came out or was removed, the graft, however, remaining as a lining for the cavity. The objection to this plan was that there was too much movement. The compound could not be kept in place as long as desired to prevent subsequent contracture. The staff of the Queen's Hospital, Colonel Newlands, Major Gillies, Major Waldron, and Major Pickerill, modified and improved Waldron's method by attaching the compound to a splint fastened to the teeth. In this manner the graft covering the compound was held firmly pressed in place. An impression of the cavity produced by dividing the scar tissue was taken in compound which was then attached to the splint, the compound being covered with a Thiersch graft and pressed down firmly in place. The compound was allowed to remain for ten days, and at the time of its removal, to avoid secondary contracture, was replaced with a vulcanite piece, worn for several weeks. Lt. Col. G. C. Schaeffer, M. C., U. S. A., holds the modelling compound in place by passing sutures through the cheek or the floor of the mouth and tying them over gauze on the skin surface. This is a simple method, but should be used only where it is impossible to obtain a dental appliance.

In the Maxillo-Facial Service at U. S. Army General Hospital No. 11 at Cape May, I used the method employed at the Queen's Hospital, but found several minor changes desirable:

1. We dissected out the scar tissue, enlarged the cavity much beyond what was desired, then put the jaws in an open-bite splint (Figs. 1 to 5).

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I find others do not use this splint as much as we did. Its advantages are that it keeps the mouth in one position and in an over-corrected one, so that the final result will not be interfered with by subsequent contracture. I strongly advise the open-bite position for these cases.

2. We retained the original compound in place for fourteen to twenty-one days and always followed its removal by the insertion of a vulcanite model for several weeks. The graft should not be sutured over the compound as it defeats the object desired; that is, the compound is only supposed to hold the graft against the raw surface. The point to be remembered is that the compound should be held in place under pressure. If any of the graft extends over normal mucous membrane, it does not do any harm.

In lining a skin flap with Thiersch graft as in Figs. 7 and 8, the



FIG. 13.



FIG. 14.



FIG. 15.

appliance is put in place, the flaps are made, and then the compound is covered with the graft; finally, the flaps are sutured over the compound, in contact with the graft. The lining of skin flaps in this manner was entirely satisfactory, but where possible a full thickness skin flap is preferable. One would frequently see the patient vomit over the grafts immediately after the operation. No harm resulted.

The Thiersch grafts in the mouth were pale in color, but several months later changed and became much the same as normal mucous membrane. In lining the nose with epithelium, which is an essential in rebuilding a nose, it is frequently impossible to obtain sufficient skin to make a flap for this purpose. To overcome the difficulty, we had an attachment connected to an appliance on the teeth bearing a mould of wax or modelling compound over which the outer skin flap would fit accurately (Figs. 10 to 15). On the inner surface of the skin flap was applied a Thiersch graft. So long as the flap accurately covered the mould, just so long did one get the grafts to take. A Thiersch graft will take in any part of the nose if held accurately in place.

## OPERATIVE TREATMENT OF UNUNITED FRACTURES OF THE MANDIBLE\*

BY ROBERT H. IVY, M.D., D.D.S.  
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THIS report is based upon observation of twenty-two patients with non-union following gunshot fracture of the mandible, in the writer's service at the Walter Reed General Hospital. These cases came to operation after the lapse of periods ranging from six to seventeen months

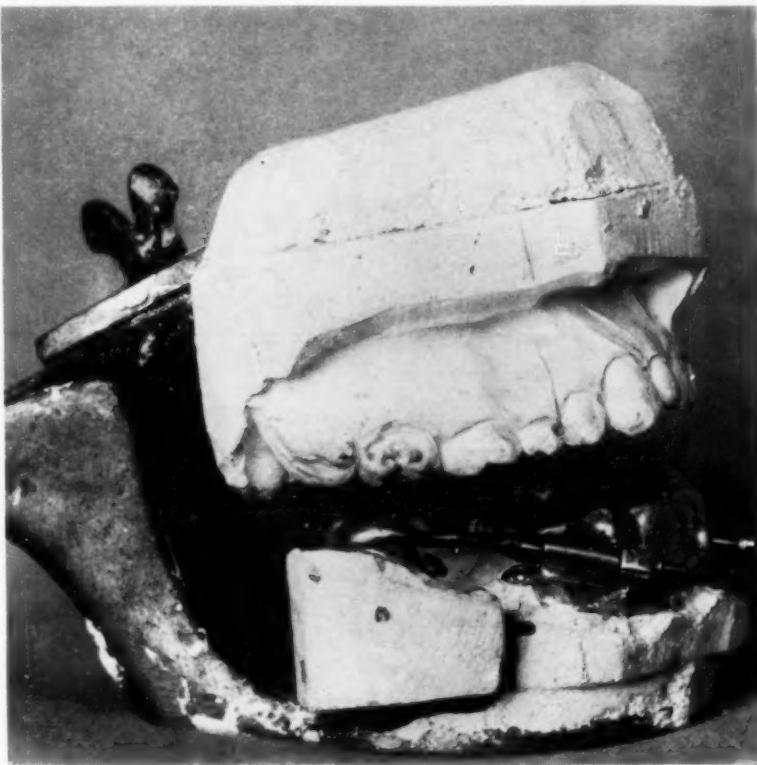


FIG. 1.—Cases VI, VII, VIII and XXII. Type of splint suitable for cases with sound teeth in each fragment. Band around molar tooth in posterior fragment, connected to segment of splint on anterior fragment by adjustable screw-bar.

following the original injury. In all cases a thorough trial had been given to conservative methods of treatment. In twenty-one there was free mobility between the fragments; in one a rather firm fibrous union in very bad position had occurred, complicated by large loss of substance. The non-union in these cases was primarily not due to lack of early fixa-

\* Read before the Philadelphia Academy of Surgery, December 1, 1919.

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tion, but was principally caused by the large loss of bone substance and inability on the part of nature to bridge the gap resulting when the collapsed fragments were drawn apart and fixed in proper position. The loss of bone was due not so much to primary destruction as to extensive shattering followed by infection and necrosis. If the fragments had not received early attention in the form of reduction and fixation, we should have had a much larger number of cases of union in bad position, requir-

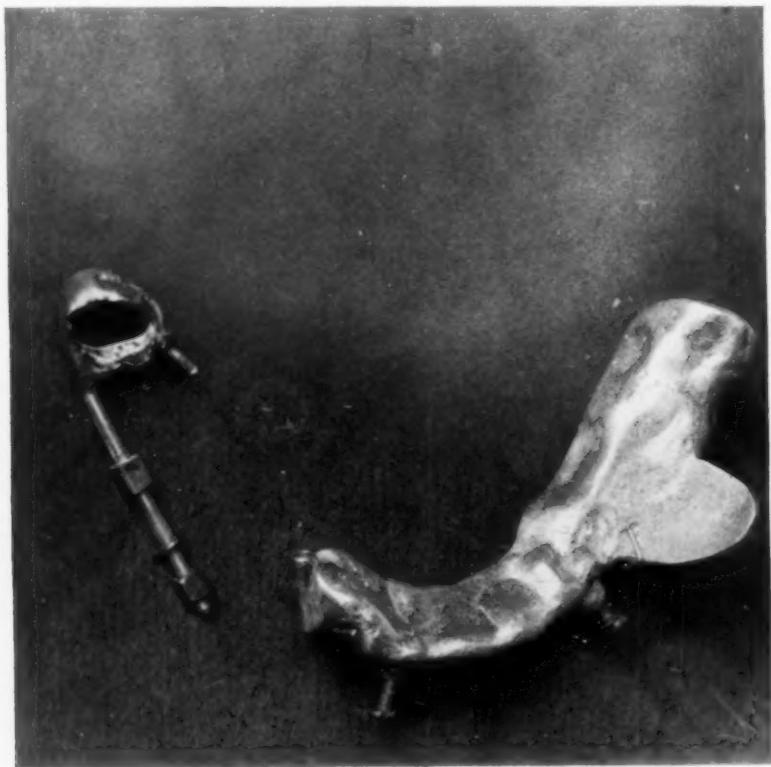


FIG. 2.—Same splint unassembled, showing flange on side opposite fracture to keep mandible from swinging over to affected side during mastication. Flange plays against upper molar teeth.

ing two separate operations of surgical reduction and bone grafting, instead of grafting alone. At the present time exact figures are not available giving the percentage of cases of non-union in gunshot fractures of the mandible seen in the recent war, but the writer would roughly estimate it at ten per cent.

Of the twenty-two cases operated upon, eleven involved the body, three the symphysis, two the symphysis and body, three the angle, one the angle and ramus, and two the ramus.

The object of treatment in these cases is primarily restoration of the function of mastication. This is attained by restoring the normal occlu-

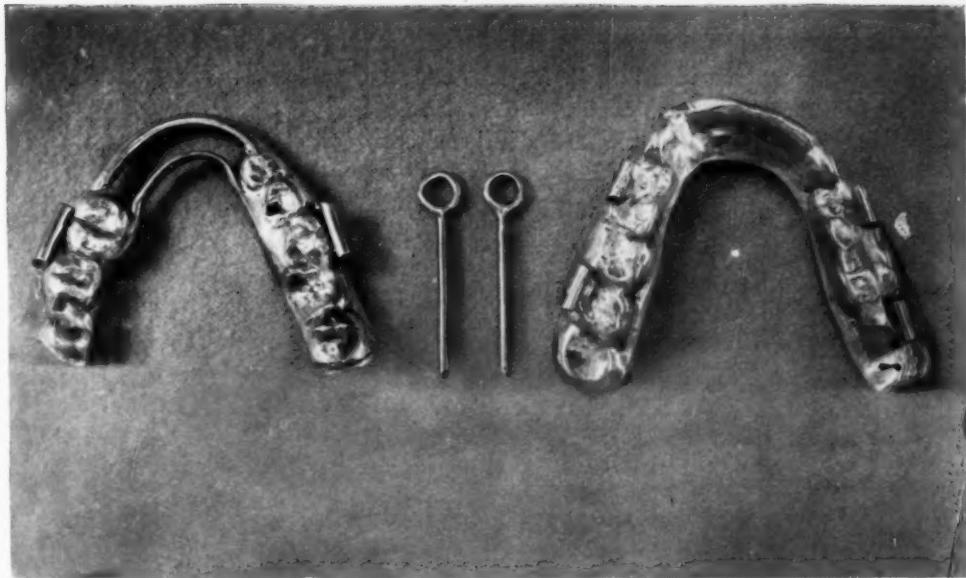


FIG. 3.—Case XIII. Upper and lower cast metal splints with removable lock-pins to permit opening of mouth if desired.

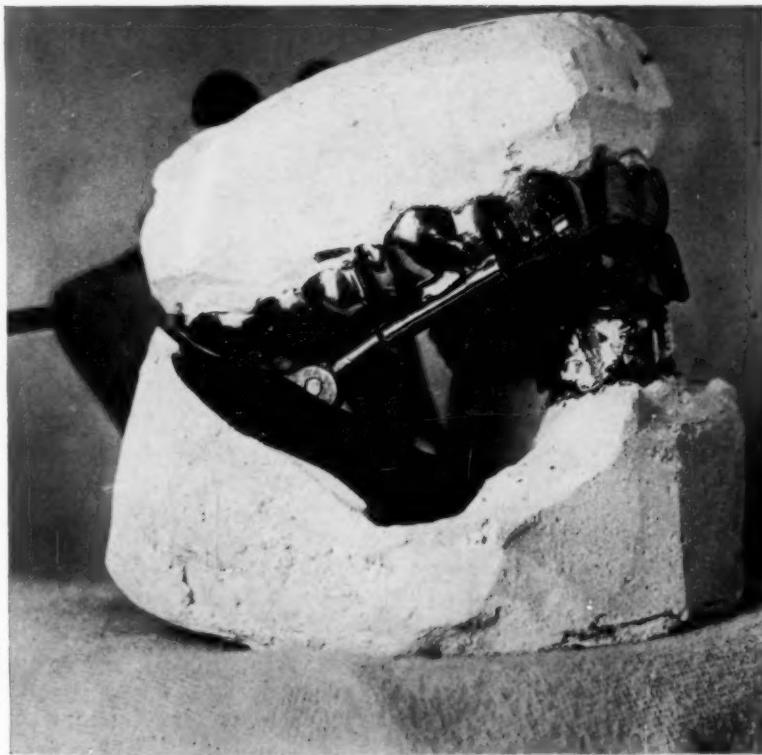


FIG. 4.—Cases IV, XIV, XVII, XVIII and XIX. Vulcanite saddle for ramus attached by extensible threaded rod to splint on upper teeth. Sound side of mandible held over in place by splint attached to upper by lock-pins.

sion of the teeth and filling in the lost continuity of the bone. One is of little value without the other.

The *preoperative* treatment of these cases was that applied to all fractures where union without operation is expected, namely, removal of all septic foci, reduction, and fixation in such position that the normal occlusion of the teeth is restored.

Septic foci include roots of teeth projecting into the seat of the frac-

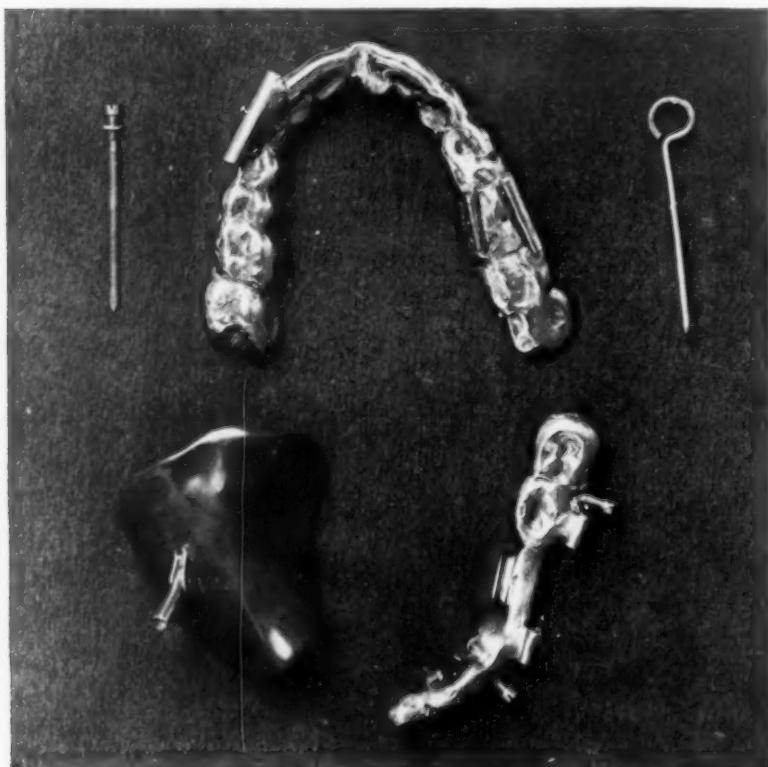


FIG. 5.—Same splint unassembled.

ture, other teeth showing evidence of periapical and periodontal disease, bony sequestra, metallic foreign bodies, and infection in the soft tissues overlying the seat of fracture. No operation should be attempted to restore the continuity of the bone until all sources of infection have been removed and until at least six weeks have elapsed after all sinuses and septic wounds have healed.

Reduction is brought about in cases of non-union by manipulation and the immediate insertion of a previously made splint which fits on the teeth and maintains the normal occlusal relationship between the upper and lower teeth. Occasionally, where there are many sound teeth it is

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possible to fix the fragments by means of wire ligatures attaching the lower teeth to the upper. The interdental splints are cast in silver after accurate impressions and plaster casts of the teeth of the individual cases have been prepared. In some cases the splints are made in segments, one for each mandibular fragment, connected by an adjustable screw-bar whereby reduction can be gradually brought about. Where there are sound teeth in each fragment, it is frequently only necessary to splint

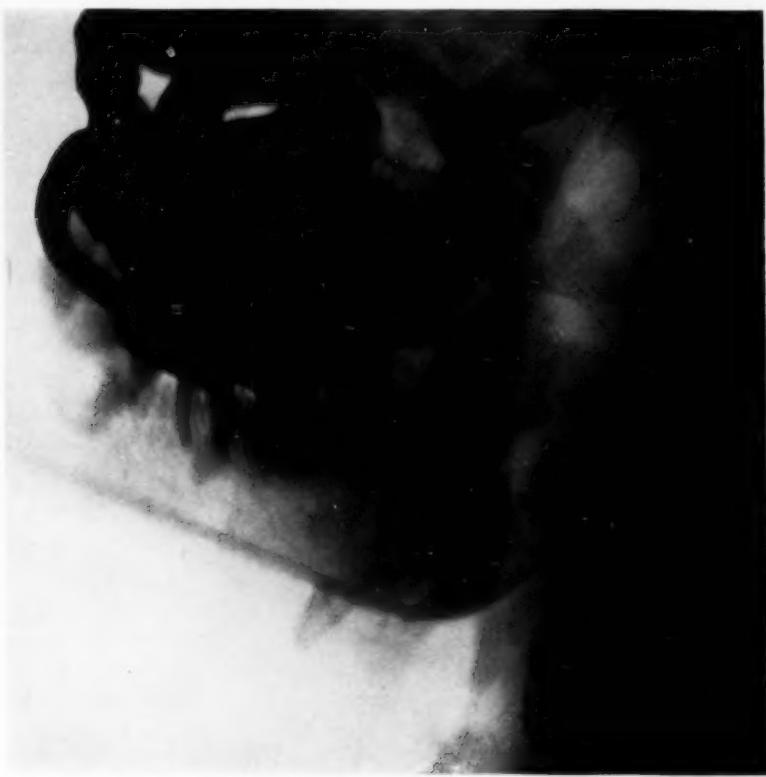


FIG. 6.—Case XIII. Loss of 2.5 cm. at symphysis, before operation.

the mandible (Figs. 1 and 2). This has the great advantage of permitting mastication and also allows enough motion to promote bone growth. In other cases, and always where there are no teeth in the posterior fragment, as in the case of fracture at the angle, it is necessary to splint the upper teeth as well as the lower and lock the two splints in occlusion by means of removable bolts on each side (Fig. 3). The upward and forward tilting of the ramus of the mandible by the action of the masseter and internal pterygoid muscles is gradually corrected by means of a vulcanite saddle covering the soft tissues of the ramus, backward and downward propulsion being obtained by a threaded rod connecting the

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saddle to the upper splint (Figs. 4 and 5). It has been found advisable to remove the saddle after reduction has been accomplished and before performing the bone graft operation, because it causes some irritation to the soft tissues and may lead to infection of the graft. Acknowledgment is due to my associates Major Joseph D. Eby and Captain Roy L. Bodine, of the Dental Corps, for their most efficient and necessary co-operation in handling the problems of reduction and fixation in these cases.

In cases of firm fibrous or bony mal-union, operative reduction must



FIG. 7.—Case XIII. After pedicled graft. Did not unite on one side and required reinforcement by osteoperiosteal graft.

be resorted to. The skin is divided, the seat of fracture exposed, and the line of union cut through to permit complete separation of the fragments to their normal position, which is maintained by the application of previously prepared dental splints. If the mucosa of the mouth has not been opened by this procedure, a graft may be at once inserted. If the mouth cavity has been made to communicate with the external wound, the bone graft operation must be postponed until complete healing has taken place. This applies also to accidental opening of the mucous membrane of the mouth in preparing a bed for a bone graft. The graft will not live in the presence of infection from the oral secretions. I was unfor-

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tunate enough to have this accident occur in two cases of the present series, necessitating immediate discontinuance of the operation and postponement of the bone grafting for several weeks.

*Operative Procedures.—Anæsthesia.* In all cases ether anæsthesia was used. It was given intrapharyngeally through nasal tubes. The bottle containing the ether was attached to an oxygen tank, the bubbles of oxygen carrying the ether to the patient, there being thus no necessity for a foot bellows or motor pump. It was never found necessary to use the



FIG. 8.—Case XV. Loss of 1 cm. in right body of mandible, before operation.

intratracheal method. The technic employed permitted continuous administration of the anæsthetic and at the same time complete isolation of the field of operation by sterile towels which covered the entire head and face, except the seat of fracture.

*Types of Graft.*—Three different methods of restoration of the lost bone substance have been used in the present series, as follows:

- (1) Pedicled bone graft from the mandible itself.
  - (2) Osteoperiosteal graft from the tibia.
  - (3) Graft from the crest of the ilium.
- (1) *Pedicled Graft.*—The method followed is that described by Cole

(*British Journal of Surgery*, July, 1918), in which a piece of the lower border of the anterior fragment is removed by means of an electrically driven saw, with a pedicle of digastric muscle and fascia left attached to it below for nourishment. This is carried back to fill the gap and fastened to the ends of the fragments by means of silver wire.

(2) *Osteoperiosteal* method of Delangenière (*Bull. et Mém. Soc. Chir.*, Paris, May, 1916). This consists in first exposing the ends of the fragments and preparing a pocket around each by stripping back the peri-



FIG. 9.—Case XV. Shortly after pedicled graft operation.

osteum and soft tissue for a distance of about 1 cm. The graft is made by the removal of a thin shaving of bone from the antero-internal surface of the tibia with a chisel, leaving the overlying periosteum attached to the graft. One piece of this is inserted in the pockets beneath the ends of the mandibular fragments and another in a similar manner over the fragments, with the bony surfaces of the grafts facing each other. It is necessary that the grafts be in contact with the previously freshened bone ends. No fixation is used beyond suturing the deep tissues over the grafts and ends of the bone, dependence in this respect being placed entirely upon the splints. The osteoperiosteal graft is flexible, easily

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adjustable to the size and shape of the lost bone substance, and contains all the elements necessary for osteogenesis.

(3) *Crest of the Ilium*.—After first thoroughly exposing the ends of the fragments they are trimmed off and freshened, and a hole is drilled in each through which a silver wire is passed. An incision is now made along the crest of the ilium, beginning at the anterior superior spine, the muscles attached to its inner and outer surfaces are stripped down, and a piece of bone of sufficient length and depth removed to fill the gap in the



FIG. 16.—Case VII. Before sepsis had cleared up, showing drain in place.

mandible. A hole is drilled in each end for passage of the silver wires for connection to the mandible. The detached muscles are brought over the site of removal of the graft, and sutured together with catgut, and the ilium wound closed.

Space will not permit the giving of many of the details of these operations here, but a few points will be mentioned. Whichever of the three methods be used, the grafts must not be touched with the gloved hands, and should be transferred immediately from their original site to their new environment. Careful haemostasis must be carried out before insertion of the graft and again before the wound is closed. If there be slight

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oozing a small rubber drain is left in place for twenty-four to forty-eight hours.

The indications for the various types of graft will now be briefly discussed.

The *pedicled* graft is satisfactory in cases of loss of substance up to 3 cm. in the body or symphysis of the mandible. It is not applicable where the ramus is involved. It has the advantage of furnishing a piece of bone that has not been cut off from its blood supply and which acts



FIG. 11—Case VII. Shortly after placing osteoperiosteal graft.

not as a mere scaffolding for the rebuilding of new bone to fill in that lost by the injury, but which is from the first an integral part of the mandible. The pedicled graft is not so vulnerable to infection as the free bone graft, and union will, as a rule, take place more rapidly than where a free graft is used. On the other hand, in the writer's experience the technic of the pedicled graft is more difficult, takes longer, and the operation is attended with more hemorrhage than in the case of the free graft.

The *osteoperiosteal* graft is regarded by the writer as being on the whole the most satisfactory for the great majority of cases, and the most universally applicable. It is suitable for loss of substance of any extent,

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and in any position. It can be made to assume almost any desired shape. The technic is the simplest. It perhaps requires longer to obtain complete consolidation than by other methods, and no dependence, of course, can be placed upon the rigidity of the graft itself for fixation.

The *crest of the ilium* furnishes a graft that can be adapted to a small or a comparatively great loss of substance. It is especially suitable in cases where immediate rigidity is desired, *viz.*, where too much dependence cannot be placed upon splints for fixation, and also for an immediate



FIG. 12.—Case VII. Showing bone regeneration, two months after operation.

cosmetic result where the loss of substance has produced much visible deformity.

*Results.*—In the twenty-two patients the graft operation was repeated in three, making twenty-five operations in all. Of these fourteen were osteoperiosteal, five were pedicled, and six were from the crest of the ilium. Of fourteen osteoperiosteal grafts, eleven, or 78.5 per cent., are completely consolidated or in process of consolidation, in two only partial regeneration took place, and had to be reoperated upon, while one was lost from suppuration. In the two cases in which regeneration failed to occur, the ramus was involved. Regeneration does not take

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place as readily nor as rapidly in the ramus as in the body of the mandible.

Of five pedicled graft cases, three are cured, while in two regeneration was incomplete and reinforcement by a second, osteoperiosteal operation was necessary.

Of the six cases of ilium graft, five are undergoing consolidation,



FIG. 13.—Case XXI. Mal-union, requiring operative reduction.

while one was lost from suppuration, and another operation will be required.

Thus, of a total of twenty-five operations, nineteen, or 76 per cent., were successful. In four of the failures, complete regeneration did not occur, while two suppurated. Of the twenty-two cases all but two are either cured or in process of firm solidification. These two still remain to be re-operated upon, and it is confidently expected that a good ultimate result will be obtained in them.

In both of the cases in which the graft was lost from suppuration the saddle extension splint was used over the soft tissues of the ramus and caused considerable irritation from pressure. Therefore, it is now considered wiser to use the saddle only to reduce the displacement of the ramus and to remove it before the operation.

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In all cases but one the occlusion of the teeth will be good after removal of the splints and replacement of lost teeth. In one case the splint slipped at one end several days after the operation, and the occlusion will not be perfect.

The splints are kept in place for at least three months after the graft



FIG. 14.—Case XXI. Showing ilium graft in place.

operation, this depending upon the extent and seat of the loss of substance. The teeth are unlocked at intervals to permit gentle exercise and stimulate bone growth. Follow-up radiographic examinations are made once a month.

The appended table gives a summary of the twenty-two cases:

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## SUMMARY OF CASES

Case	Date of injury	Seat of injury	Substance lost	Method of fixation	Date of operation	Type of graft	Result
1NC	7/30/18	L. angle	2 cm.	Intermaxillary wiring of teeth	4/4/19	Osteo-periosteal	Cured
2OK	10/4/18	L. angle	3 cm.	Cast intermaxillary splints	4/25/19	Osteo-periosteal	Cured
3EH	9/26/18	R. body and symphysis	4 cm.	Cast intermaxillary splints	6/23/19	Osteo-periosteal	Consolidation taking place
4PG	10/10/18	L. body	3 cm.	Intermaxillary splint and saddle	7/11/19	Osteo-periosteal	Consolidation taking place
5PD	7/30/18	L. angle and ramus	3.5 cm.	Cast intermaxillary splints	4/22/19	Osteo-periosteal	Only partial regeneration
6MM	9/29/18	R. body	2.5 cm.	Cast mandibular splint	5/12/19	Osteo-periosteal	Cured
7FM	10/11/18	R. body	3 cm.	Cast mandibular splint	5/28/19	Osteo-periosteal	Cured
8JM	7/4/18	R. body	2 cm.	Cast mandibular splint	7/9/19	Osteo-periosteal	Cured
9WS	9/28/18	L. ramus	2.5 cm.	Intermaxillary wiring of teeth	7/14/19	Osteo-periosteal	Consolidation taking place
10EO	7/17/18	R. body	2 cm.	Intermaxillary wiring of teeth	7/30/19	Osteo-periosteal	Consolidation taking place
11HB	7/28/18	R. ramus	1.5 cm.	Intermaxillary wiring of teeth	(1) 5/7/19 (2) 9/19/19	Osteo-periosteal	Only partial regeneration
12OH	9/26/18	L. body	1 cm.	Intermaxillary wiring of teeth	3/26/19	Pedicled	Consolidation taking place
13RP	5/31/18	Symphysis	2.5 cm.	Cast intermaxillary splints	(1) 4/2/19 (2) 7/21/19 8/13/19	Pedicled	Only partial regeneration
14HS	10/15/18	Symphysis and r. body	4 cm.	Intermaxillary splints and saddle	8/13/19	Osteo-periosteal	Cured
15CH	10/14/18	R. angle	1 cm.	Intermaxillary wiring of teeth	8/27/19	Pedicled	No union at one end
16FS	9/28/18	Symphysis	2 cm.	Removable spring clasp splint	8/29/19	Pedicled	Cured
17CD	9/26/18	R. body	3 cm.	Intermaxillary splints and saddle	(1) 4/18/19 (2) 8/8/19	Osteo-periosteal Ilium	Lost from suppuration
18AR	9/26/18	R. body	2.5 cm.	Intermaxillary splints and saddle	8/25/19	Ilium	Consolidation taking place
19JB	7/15/18	R. body	5 cm.	Intermaxillary splints and saddle	8/18/19	Ilium	Lost from suppuration
20GC	10/8/18	R. body	2.5 cm.	Cast mandibular splint	9/5/19	Ilium	Consolidation taking place
21CF	3/4/18	Symphysis	5 cm.	Cast intermaxillary splints	8/22/19	Ilium	Consolidation taking place
22AT	7/29/18	R. body	2.5 cm.	Cast mandibular splint	9/12/19	Ilium	Consolidation taking place

## BONE INLAYS AND BONE PLATINGS

BY RICHARD J. BEHAN, M.D.  
OF PITTSBURGH, PA.

IT has been stated by the advocates of bone plating that bone plating can be done in certain cases where to do an inlay would be impossible.

I shall briefly describe a case where, apparently, this difficulty existed, but, nevertheless, the difficulty could have been overcome if we had exercised ingenuity at the time of operation and had applied a mechanical principle which was very apparent afterward.

The patient had been injured some time previously by a fall of slate which caused an over-riding fracture of the lower portion of the humerus. It was impossible to hold the fragments in position by any form of traction apparatus. This was partially the result of the very marked muscular development of the arm.

An open operation was done. A piece of bone was cut from the upper fragment, forced into the medullary cavity, and driven into the medullary cavity of the lower fragment. In doing this a portion of the upper fragment, which had been fractured, came away entirely. Because of this it was impossible to keep the intramedullary splint in place in the upper fragment. A bone band was thrown around but did not seem to act efficiently. Two sutures of kangaroo tendons were then placed around the intramedullary inlay and the lower end of the upper fragment and seemed to hold the fragments in place. The fragment of the bone which had separated entirely was then removed, as it could not be placed back in position.

The arm was now put up in splints in proper position. However, a picture taken some time later showed that there was an inward displacement of the upper end of the lower fragment and that the inlay, which had been inserted into the medullary cavity of the lower fragment, was overriding the upper fragment and lay to the inner side of this fragment.

There was also present a slight musculospiral paralysis.

A second operation was performed December 24, 1919. The arm was exposed, cleansed with iodine, and an incision was made to the outer side of the old scar. There did not seem to be much muscular tissue beneath the scar tissue, the scar being in contact with the bone. Careful dissection was made until the musculospiral nerve was found. It curved around in the groove in the angle between the two fragments. It was surrounded at one point by very dense scar tissue. This scar tissue was separated and the nerve was freed from its bed. Care was taken not to injure the two branches passing out of the triceps muscle. The nerve at the point where the scar was present seemed to be oedematous, rather dark in color, and slightly thickened. Below this point it seemed to be of normal

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size and consistency and of normal color. It was drawn to one side by means of a piece of gauze placed beneath it, to protect it from injury during the further manipulation. The two fragments were now separated and the lower fragment was found to still have, in the medullary cavity, the intermedullary bone peg, which had been inserted at the previous operation. The upper fragment of the bone was separated from the lower. The lower end of the upper fragment had a well-marked rounded prominence. An attempt was now made, by drilling a hole up through the lower frag-

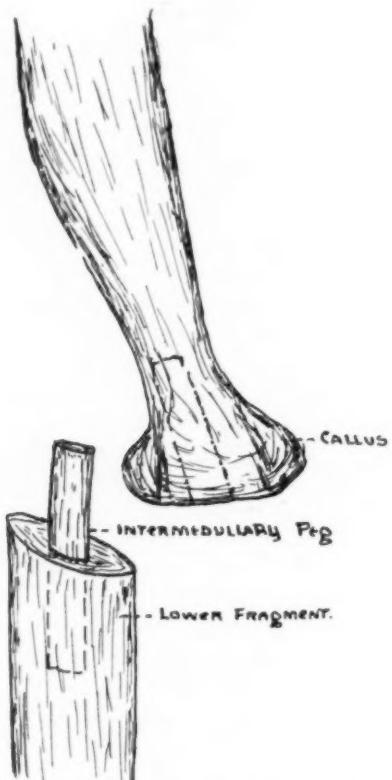


FIG. 1.—Showing the pathology found at the time of the second operation. The dotted line shows the tunnel in bone into which the bone peg was inserted.

ment, to insert the bone peg (Fig. 1). After it was inserted, however, the callus gave way and angulation again took place. An attempt was then made to groove the inner surface of the upper fragment and to hold the peg by means of a bone band (Figs. 2 and 3). This was also unsuccessful. Then the peg was removed from the lower fragment and the upper fragment was sharpened and forced down into the medullary cavity of the lower fragment, and seemed to hold very well (Fig. 5). Holes were drilled through the lower part of the upper fragment and a kangaroo tendon was inserted and tied. This seemed to hold very well, except at this point

## BONE INLAYS AND BONE PLATINGS

the intramedullary part of the upper fragment, somehow, through manipulation, became broken. It was now necessary to place a bone plate on the inner surface of the bone (Fig. 6). The musculospiral nerve was then drawn to one side. A new path was made for it so

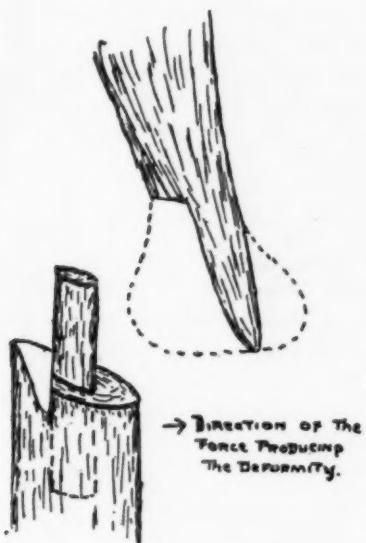


FIG. 2.—Second attempt at reduction.



FIG. 3.—Third attempt at reduction.

that the nerve lay in fatty tissue. The muscle was drawn over the end of the fragment and sutured to the fascia on the opposite side of the incision. The skin and superficial tissues were closed. The arm was placed in right-angular extension.

Fig. 4 illustrates perfectly the method that would have held the

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FIG. 4.—Method which should have been used.



FIG. 5.—Fourth attempt at reduction. Tapering peg made by shaping the upper fragment. (Schematic)



FIG. 6.—Fifth attempt at reduction. Bone band used.

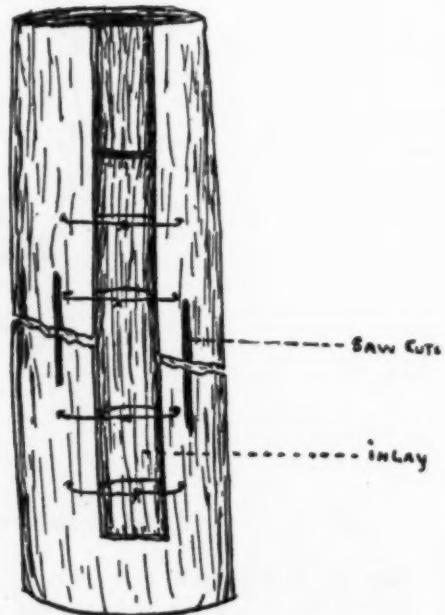


FIG. 7.—Shows inlay inserted—with the parallel saw cuts.

## BONE INLAYS AND BONE PLATINGS

bones in position. Because of their tendency to inward displacement, the wedging-in of the lower portion of the upper fragment between the intramedullary peg and the cortex of the bone of the lower fragment would have held them firmly in position. Then if a bone band had been placed around the fragments in this position and two sutures of kangaroo tendon had been inserted, as indicated, it would have been impossible for the bone to become displaced.

However, this was not thought of until after the operation had been completed. Nevertheless, it is a worthy suggestion that may be attempted successfully at the next operation for this type of fracture.

Because of the inability to hold the fragments in position that the bone plate was applied in this case. However, if we had used the method which I describe and which I suggest above, it would not have been necessary to have used the bone plate. In doing bone inlays I have also found it very advantageous, in order to hasten osteogenesis, to make several slits in the bone, parallel to the longitudinal axis, as illustrated in the accompanying cut (Fig. 7).

This is also a very useful method where an intermedullary splint has been used.

## A CONSIDERATION OF THE SURGICAL HAZARDS IN DIABETIC PATIENTS

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AN increased risk of operation when the surgical disease is complicated by diabetes is quite generally recognized, but it is not so commonly appreciated that complications which might be regarded as surgical are the immediate cause of death in a large proportion of cases of diabetes. While statistics based upon hospital records are not completely satisfactory, since only certain types of disease are apt to be admitted to hospital, yet, in a general way, data of this sort are significant. A careful review of the clinical records of two good hospitals brought out the following somewhat surprising facts. Of the fatal cases of diabetes dying beyond the third decade of life, about 60 per cent. of the fatalities occur following operations. Of the surgical cases with a fatal termination, 70 per cent. die in coma. It has been the habit, apparently, to endeavor to make some estimate, in cases such as the above, as to the degree of severity of the diabetic state, and the terms commonly employed are mild, moderate, and severe. The estimations of the severity of the disorder were based evidently upon the glycosuria. Accepting this classification for what it is worth, it is found that coma occurs after operation as often in mild cases of diabetes as in the apparently severe, which, of course, means that the estimations were made upon faulty criteria.

Surgeons are accustomed to classify operations as minor or major, into which classification a number of factors enter, but the meaning of these terms is quite generally understood. Using these terms in the sense commonly accepted we find that the mortality in diabetic patients is higher following minor operations than it is in general for major operations. Of course, one recognizes here at once that major operations might not, as a rule, be attempted on diabetic patients, certainly not without consideration, but this brings more into contrast the erroneous estimation often placed upon the hazard of minor surgical procedures in diabetic patients.

These preliminary considerations bring up the questions which I wish to discuss. Although surgeons and internists alike recognize that an increased hazard attaches to any surgical operation when this operation is done upon a diabetic patient, yet it is not so generally recognized that the factors which go to make up the increased risk can be analyzed and to a very high degree estimated.

From what has already been said it would seem evident that glyco-

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suria is not a reliable guide in the estimation of the severity of diabetes, in fact, it is doubtful if it is any guide at all further than a rough diagnosis. Glycosuria does not invariably connote true diabetes mellitus; on the other hand, the absence of glycosuria does not completely exclude this disease. It is generally recognized at the present time that diagnosis and much more the estimation of the severity of the disease depends upon the degree of hyperglycæmia under varying conditions of diet.

It is not inappropriate in this connection to call attention to the type of diabetes which may not show glycosuria. Where the disease has existed for a considerable period of time renal degeneration quite commonly occurs. The earliest clinical manifestation of this complication is very often an increase in blood-pressure. In time it is noticed that the glycosuria gradually abates and, in not a few individuals, completely disappears; so that one is told by the patient that at a certain period in his life he suffered from diabetes for a number of years, but of this was "cured." A thorough examination, and especially blood-sugar estimations, reveals the true condition, which in effect is that the pathological condition in the kidney has progressed to a degree so that even a considerable increase in the blood sugar is not manifested by sugar in the urine. One may accept it, then, as established that diabetes mellitus can be diagnosed and the severity of the disease estimated only by determining the hyperglycæmia.

Relative to our discussion are those factors which influence the normal blood sugar by increasing it, since they produce the same effect to a greater extent in the diabetic state. Chief among these must be mentioned infections. Persons who are not afflicted with any metabolic disease show, when they are the subjects of chronic infections, disturbances in the metabolism of sugar, and this disturbance is characterized by an increase of the blood sugar beyond the normal limit after the ingestion of glucose and a prolongation of the blood-sugar curve beyond the normal two hours. Chronic infections in diabetic subjects induce a similar change, which is expressed clinically in the difficulty experienced in reducing by diet the hyperglycæmia to normal; moreover, this disturbance, produced by infection, implies on the part of the diabetic organism an increased difficulty in the metabolism of glucose and, on that account, the tendency to acidosis is more marked. These fundamental facts are well exemplified in even minor infections in diabetic individuals.

A diabetic patient may have progressed in a most satisfactory manner for a considerable period of time and he may have acquired an ability to utilize an appreciable amount of carbohydrate, the blood sugar remaining during this period practically normal. At this juncture he develops tonsillitis. The blood sugar increases and, even though the patient may take scarcely any food, sugar returns to the urine. A decrease in the metabolism of glucose is manifested by some degree of acidosis, even after the infection has passed. It may require a considerable period of

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time before conditions are restored to what they were prior to the intercurrent infection. In children relatively mild infections of this sort not infrequently lead to fatal acidosis and coma. The same changes in the metabolism accompany the numerous infections which require surgical treatment, carbuncles, cellulitis. The next factor that is important, in cases where surgical treatment may be required, is the influence of anaesthesia upon the carbohydrate metabolism. Every surgeon knows that glycosuria is occasionally manifested after anaesthesia. Accompanying this disturbance there is more or less acidosis, depending upon the nature of the operation and the period of time of anaesthesia. Here, then, as with infections, we have a factor which aggravates and intensifies the peculiar disorder which characterizes diabetes. The third important factor which comes in for consideration is the predisposition of the diabetic to infections and the diminished recuperative power manifested by his tissues when infections are established.

In resumé of these detailed facts it would seem evident, then, that the severity of diabetes in any given case can be estimated only by blood analyses, that infections tend to increase the severity of the disturbance of carbohydrate metabolism and, in that way, bring about a variable degree of acidosis and that the low resistance of the tissues to infection prolongs and intensifies the carbohydrate disturbance and hence of the acidosis. Anaesthesia, and especially ether, intensify the disordered processes.

A recognition of these facts should make it possible, it would seem, to determine, at least, when operation cannot be borne by a diabetic subject. These facts also suggest that an estimation of the hazards is possible in border-line cases. The chief danger is always acidosis and coma, and, for that reason, a determination of this factor is the prime requisite. Estimations of the  $\text{CO}_2$  combining power of the blood give a very definite idea of the degree of acidosis, and this estimation requires only a few minutes. Normal blood shows a combining power for  $\text{CO}_2$  above 55 per cent. Severe degrees of acidosis are evidenced by a combined power of 20 per cent. or less. No diabetic patient has come to my knowledge who has successfully withstood any operative procedure whose blood showed a combining power of less than 30 per cent. Based upon a considerable experience, it is my present opinion that with  $\text{CO}_2$  of the blood plasma less than 35 per cent. an operation is too hazardous to attempt. Forty per cent. is the lowest figure that permits a reasonable margin of safety for surgical procedures, considering the superimposed acidosis consequent upon the course of infection and the anaesthetic.

Even when the acidosis estimation gives a satisfactory result, the degree of hyperglycæmia cannot with safety be ignored. One sees many diabetics with no acidosis, but with a blood sugar over .35 per cent., who succumb to operations because of the acidosis that develops postoperatively. When the blood sugar is a higher figure than this at the time of operation a fatality is probable. One may say, then, that patients

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showing hyperglycaemia of over .35 per cent., or a CO<sub>2</sub> combining power of less than 40 per cent., cannot be expected to survive any operative procedure. The only safety with cases of this type is to change the metabolic state prior to surgical treatment. If there is not time to do this the case is hopeless.

At the other extreme are the cases with no acidosis and with blood sugar only twice normal, who survive operative procedures, even infections requiring surgical treatment, in a fairly high percentage. In all cases demanding surgical treatment, with the exception of emergencies, preoperative care is possible and, with the great majority, even with severe types of diabetes, the acidosis can be abolished and the hyperglycaemia reduced to a safe margin.

The treatment of patients with diabetes mellitus as a preparation for surgical operation requires a departure in no respect from recognized principles. The object of this treatment is the restoration of normal metabolism and the measure of success is the blood sugar and CO<sub>2</sub> of the plasma. There is but one primary means to this end, dietetic, and it is difficult for many to apprehend that in this disease food is a two-edged sword, and its use requires a nice scientific precision. In the first place, because the affections requiring surgical treatment are so frequently infections, and this infection predisposes to acidosis, attention to this factor is never subordinate. Symptoms of acidosis are protein in character and they can be anticipated by laboratory methods; then, too, radical changes in diet often produce a temporary increase of acidosis, which must be watched, and this is especially true in surgical cases. Although hazardous unless controlled by constant laboratory tests, fasting effects, with some cases, the most rapid decrease of hyperglycaemia and acidosis. Unfortunately, when infections of a surgical character complicate the primary diabetes, fasts are not infrequently accompanied by a rapid increase of acidosis. In the latter case there is no recourse except some form of nourishment. The diet at this juncture is determined by two considerations: (a) Fats are direct precursors of the ketone bodies and hence are contraindicated; (b) carbohydrates are being utilized scarcely at all by the body and therefore, if given, elevate the blood sugar and induce acidosis. This leaves only protein for food and this may be used as lean meat and eggs, with small amounts of green vegetables as a relish. The food intake should not exceed 300 calories daily at this period. In some instances a low diet such as described can be interpolated with fast days with benefit.

The use of alkalies in acidosis is general and the effect too often disappointing. When given by mouth it is essential to give large amounts—2 to 3 grammes (30-45 grains) an hour, until the CO<sub>2</sub> of the blood is raised to a safe margin. The soda is best given in Vichy water. Recently I have given soda bicarbonate emulsified in olive oil subcutaneously—

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10 to 15 grammes of soda in 10 c.c. of oil.<sup>1</sup> Attention to a copious fluid intake and catharsis is important here, as in uræmia.

This brief statement of the principles and methods gives an outline of the treatment which must be adapted to particular exigencies as they occur. Some patients with moderately advanced diabetes can, by treatment of this type, be carried through operative procedures, but not all. Some, especially those with virulent infections of the cellulitis type, do not respond to any method or procedure.

On the other hand, when the complication which requires surgical treatment is not an infection, it may not be excessively difficult to reduce the hazard incident to diabetes very considerably. The successful amputation of the breast for carcinoma, complicating moderately severe diabetes, illustrates the point. Infections, however, remain the chief problem and the operations should be considered with the care accorded to brain tumors.

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<sup>1</sup> A suggestion of my colleague, S. R. Benedict, Professor of Chemistry.

TRANSACTIONS  
OF THE  
NEW YORK SURGICAL SOCIETY

*Stated Meeting held December 10, 1919*

The President, DR. WM. A. DOWNES, in the Chair

THE ELECTRO-MAGNET RADIATOR-VIBRATOR

DR. W. C. LUSK presented a series of patients in the treatment of whom the electro-magnet radiator-vibrator of Müller had been used. These included cases of painful wound scars, an amputation stump, a stiff ankle with equinus (supramalleolar fracture), a stiff shoulder (fracture surgical neck of humerus), a stiff elbow (supracondyloid fracture without anterior-posterior displacement and fracture internal condyle), a stiff elbow (abscess arm), and a stiff finger following wound around its base. These cases were to illustrate a paper to be later published.

DR. A. P. WHIPPLE, speaking in regard to the case reported by Doctor Lusk referred by him, said that there was definite ankylosis of the arm following the cellulitis; on admission to the hospital the patient was supposed to have had an arthritis, but two or three punctures failed to withdraw pus from the joint. The cellulitis was very extensive, and the prognosis was considered bad from the standpoint of function because of the long time the cellulitis persisted, and because of the atrophy and stiffness of the muscles. Having seen this patient since her treatment by Doctor Lusk he wished to testify to the remarkable improvement in function and particularly to the loosening up of the stiffness in the dense scar tissue which was present around the elbow-joint as a result of the cellulitis.

DR. ROYAL WHITMAN, in reference to the third case of recurring discomfort in the ankle, suggested that the patient had limitation of dorsal flexion of the foot, which if definitely overcome would assure a better final result than would relief of the symptoms by the vibrator.

DR. W. C. LUSK, in closing, replying to Doctor Whitman's suggestion, said that the patient in question had come very irregularly for his treatments, having received only 29 in three and one-half months, since which time, for an interval of over eight months, up to four days ago, he had not been seen. When he reported four days ago, he had considerable limitation of dorsal flexion of the foot, but following one treatment with the magnet on that date, using vibration over the tendons around the ankle and radiation, his dorsal flexion became at once quite a little increased, so the very slight limp which he then had, and had rarely been

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seen without since recovering the use of his foot, entirely disappeared, and with another treatment yesterday the degree of dorsal flexion was further added to.

### EXCISION OF THE BODY OF THE SCAPULA FOR SARCOMA

DR. JOHN ERDMANN presented a man of twenty years who was first seen by him some five weeks before, when he gave the history that for one year he had suffered excruciating pain in the right shoulder, was unable to sleep, and had lost weight. On examination there was a large tumor occupying the body of the scapula on the right side. Four weeks ago the scapula was excised, leaving the neck of the scapula, chiselling through the spine and acromion posteriorly and then through the scapula. The tumor involved the two sides of the bone symmetrically. He has gained rapidly in abduction, which Doctor Erdmann believed to be due to the adherent attachments of the stumps of the muscles associated with the head of the humerus. Examination of the growth showed it to be an osteosarcoma. Good healing without sloughing has occurred.

DR. ROYAL WHITMAN said that after paralysis of the shoulder muscles from anterior-polio-myelitis patients learn to elevate the arm by means of the biceps and coracobrachial muscles. He thought that the abduction in Doctor Erdmann's case might be thus explained.

### MIKULICZ OPERATION FOR CARCINOMA OF THE SIGMOID

DR. SEWARD ERDMAN presented a man who, at the time of admission to the New York Hospital in October, 1916, was sixty-six years of age. He gave the history that for two years he had had occasional bloody stools, which he thought due to hemorrhoids, with mucus; there had been constipation with tenesmus and spasmodic pain in the rectum. He had been losing weight for a year and there was marked weakness. Four weeks prior to admission he had fainted at stool. On admission he had obstipation, passing only blood and mucus by stool, and suffered a great deal of pain in the lower left abdomen. He was very anæmic, his blood examination showing red blood count, 3,200,000; haemoglobin, 26 per cent.; white blood count, 11,000; polynuclears, 72 per cent.; negative Wassermann. On October 23, 1916, he was transferred to the surgical service, where a proctoscopic examination revealed an ulcerating tumor projecting into the rectum with no lateral attachments that could be reached by the finger; it was a nodular tumor evidently invaginated from higher up and reaching to within three inches of the anus. An X-ray was taken, but the barium enema did not reach the descending colon. On October 30, 1916, an exploratory laparotomy was performed; on opening the abdomen a mass 3 inches in diameter and 4 inches long was found in the pelvis invaginated into the rectum. This was reduced by light traction and proved to be a tumor of the sigmoid at a distance of 10 inches from the

## MIKULICZ OPERATION FOR CARCINOMA OF THE SIGMOID

anus. There were no palpable glands discovered and no evidences of metastasis in the abdomen. As there was a long mesosigmoid it was decided to draw out the whole loop through a left iliac incision, and this was done after ligating the mesosigmoid opposite the tumor for a distance of about 5 inches in order to have less bleeding at a later stage. Then the whole loop of intestine 8 inches in length was brought out through the intermuscular incision, but not opened at this time. Four days later with the cautery the loop of bowel, except for a proximal and a distal stump of about 1 inch each, was removed, gas-oxygen anaesthesia being used. Following this procedure he continued to gain in strength and the artificial anus was quite satisfactory. Three weeks after the original operation, without using any anaesthetic, a right-angled clamp was applied to the spur between the two loops of bowel; five days later the clamp had cut through and the patient had the first normal passage per rectum. Under local anaesthesia on the thirty-seventh day after the first operation the bowel edges were freed and then closed with Lembert sutures; the skin and subcutaneous tissues were closed with three interrupted silkworm-gut sutures, there being no attempt at muscle repair. On December 20, 1916, the patient left the hospital with a healed wound, but with a hernia. There had been no attempt at repair of this hernia as the patient had done so well.

The report on the growth was malignant adenoma of the large intestine, polypoid, representing an early stage of adeno-carcinoma.

DR. W. S. SCHLEY presented two cases in which the Mikulicz operation for tumor of the sigmoid was performed. Both of these cases were adeno-carcinoma of the sigmoid. The first patient was operated last January, having been first seen in the out-patient department and referred to the medical service for examination. She complained of slowly increasing constipation. Proctoscopic examination disclosed a growth in the lower sigmoid, and she was therefore transferred to the surgical service. A median laparotomy was done, and at the same time a colostomy performed on the left side, bringing out a loop of gut, which was immediately opened into proximal side and large tube inserted, held by double purse-string suture to secure immediate evacuation. Doctor Schley had never seen any peritoneal soiling from this procedure; the suture usually lasts from three to five days without leakage, and by that time peritoneal adhesion is sound. Two weeks later it is his practice to resect the growth, make an anastomosis, establish drainage, and ten days later put a double clamp on the spur created and thus cut a good-sized opening. A double clamp is utilized because it gives a more complete and easier anastomosis and makes the closing of the colostomy wound much easier than a single clamp. This patient did well until during her convalescence she developed an acute cholelithiasis requiring the performance of a cholecystectomy. At the present time both wounds are in very good condition, showing simple linear scars and entirely free from herniation.

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The report on the tumor was adeno-carcinoma of the circular, or angular, constricting button type. There had been no evidence of metastasis.

The second patient preferred to continue to wear a colostomy apparatus to having his side closed. He was operated *two and a half years ago*, having entered the hospital with an acute obstruction, the result of a gradually increasing constipation. His median scar is very good and there was no bowel protrusion at colostomy. It is hoped that before long he will accede to the suggestion of complete closure. The report upon the tumor was also adeno-carcinoma.

In reference to such cases Doctor Schley laid stress upon the advantage of a *long spur* of bowel over a short one for an easy anastomosis by clamp; upon transfusion prior to operation in cases showing a haemoglobin below 60 per cent., and in the creation of colostomy by intramuscular incision.

### THE MIKULICZ TWO-STAGE OPERATION OF PARTIAL COLOSTOMY

DR. CHARLES N. DOWD read a paper with the above title, for which see ANNALS OF SURGERY, February, 1920, p. 155.

He also presented the patient referred to as Case III in his paper. Since leaving the hospital he had gained thirty pounds in weight and was in excellent health. He had done routine work as a policeman for a part of the time. He had a small hernia which gave him almost no discomfort.

DR. JOHN DOUGLAS showed a patient in whom resection of the cæcum and ascending colon was performed in three stages who was an exhibition of the three-stage operation rather than of the Mikulicz operation. She entered St. Luke's Hospital in December, 1917, with symptoms of acute obstruction in the region of the hepatic flexure and beginning of transverse colon. She had had an acute attack of pain twenty-four hours previous to admission, the bowels had not moved for forty-eight hours, and she had had symptoms of a general gastro-intestinal type for over ten years. On admission she was acutely ill and in poor general condition; therefore a cecostomy only was done, opening the intestine at the highest possible point proximal to her obstruction; at this time it was possible to see the growth, which was a carcinoma of considerable size, at the hepatic flexure, densely adherent to the duodenum. It did not appear that resection would be possible. Two days later the gut was opened by Doctor Douglas. The patient proving very uncomfortable from the cecostomy with a high colostomy, and having stood the first operation so well, it seemed justifiable to attempt an ileo-colostomy. Therefore, on February 2, 1918, a second operation was performed, making a right rectus incision inside the cecostomy opening, cutting off the ileum close to the ileocæcal valve and making a lateral anastomosis distal to the growth. The patient recovered so well from this second procedure that Doctor Douglas explained to her the advisability of attempting the removal of the growth, to which she acceded, and on March 2, 1918, he

## MIKULICZ TWO-STAGE OPERATION FOR PARTIAL COLOSTOMY

performed the third operation. This proved rather difficult; the growth was extensively adherent to the duodenum and in separating it a portion of the duodenal wall was damaged, but not opening the mucous membrane. The patient, however, recovered from this third operation, showing very little reaction, and three weeks later was discharged with the wound entirely healed. There is now a hernia resulting, however. There has been no sign of recurrence, she has kept up her weight, and at sixty-five years is as well as ever. Report was an adeno-carcinoma of the cæcum.

DR. WILLY MEYER believed that the procedure of Mikulicz, which brings the malignant tumor at once outside of the body and at the same time permits of the closure of the peritoneal cavity, was of great advantage. It should be the operation of choice wherever the gut can be brought in front of the abdominal wall. Yet not infrequently it is necessary to proceed in a different manner. He cited three cases operated on in the course of last winter in each of which he had to pursue a different course. The first patient was a female who had a large adherent carcinoma in the ileocæcal region and also suffered from pronounced secondary anæmia. Drainage was necessary; an immediate extensive operation was considered unadvisable. Therefore, a median incision was made and an ileo-colostomy with the transverse colon done. Eighteen days later the ordinary incision over the ileocæcum was made, the tumor removed with the lower end of the ileum and the ascending colon; both ends were then inverted and firmly closed. The patient made a good recovery.

The second case was one where the X-ray was misleading. The patient was admitted with the symptoms of intestinal obstruction; she was a woman of sixty-three years who had intermittent painful peristalsis, but nothing palpable. The barium-clysm showed a free passage up to the ileocæcal valve. On this evidence her family physician asked that she be transferred to the medical service. Showing more symptoms of intestinal obstruction, she finally developed a pronounced tympanites and was returned for surgical treatment; an artificial anus was made in the cæcum. Doctor Meyer believes it a good procedure to stitch the cæcum through a McBurney incision to the abdominal wall and then with the pointed Paquelin cautery open the gut, if possible, in two stages. A large tube is wedged into this opening and stitched to the dressing. In the case referred to there was perfect drainage. Two weeks later a median incision was made, the tumor was resected, both ends were inverted, and lateral anastomosis done. The patient made a good recovery.

In the third case there were no symptoms whatever of intestinal obstruction. On vaginal examination a suspicious tumor was palpated. A left rectus incision showed a cancer in the left parametrium of the lower sigmoid which was adherent to the bladder. After exposure the mesosigmoid was not long enough to allow of its being brought in front of the abdominal wall. Here a one-stage operation was done—resection and end-to-end anastomosis. The patient recovered.

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"In some of these cases internal drainage (lateral anastomosis) at the first stage is commendable, e.g., if patients object to the temporary colonic anus at the same operation. The surgeon will at the second operation often be surprised at the uniform adhesions that are found at the end of two weeks. However, they are easily separated and probably do not persist. One of his patients operated upon in this way more than ten years ago is perfectly well at the present time and has never complained of intestinal trouble.

"The artificial caecal anus, made with the pointed Paquelin cautery and the McBurney incision, has proved very satisfactory in cases where it seemed indicated."

DR. JOHN A. HARTWELL said that he wished to emphasize the statement made by Doctor Dowd that the operation of choice as these cases came for relief was the Mikulicz two-stage operation, but that if they came at an earlier period in their disease than is now the case, a great many of these cases could be operated by the one-stage operation. In the cases referred to in his statistics more than 60 per cent. were either acutely obstructed, say, of two or three days' duration, or perforation of the growth had occurred with resulting abscess, before admission to the surgical ward, and in such cases some sort of drainage must be done at once. Where the condition is reached earlier and the growth is not too adherent and has not produced a complete obstruction, the one-stage operation can often be done. With reference to the statistics from the Mayo Clinic it should be borne in mind that a large percentage of these patients were not acutely obstructed. These cases come from a distance and are in fair condition on arrival, so that generally speaking the operation is not for an emergency condition; therefore, the statistics are not comparable with those resulting from emergency work; his own statistics had only to do with the carcinoma of the splenic flexure where the disease was deeply situated, very adherent and hard to get out. Doctor Hartwell inquired whether Doctor Dowd had found it an easy matter to bring up the two loops of the intestine with the growth outside the abdomen, and bring the efferent loop in close approximation to make a good double-barreled loop for later opening of the stoma.

DR. CHARLES L. GIBSON said that although he had personally performed the Mikulicz operation only a few times, he believes if the operation is done under pretty sharp limitations that it is one of the best operations in surgery. He cited one case well at the end of seven years. In this case when the tumor was cut away the section showed deposits of cancer in the mesentery, and for this reason he kept the wound open for several months under the pretext to the patient to have it just right before closure. After cauterizing the area once or twice a week for several months it was closed. The Mikulicz operation is distinctly indicated in the second rather than in the first half of the colon. Doctor

## MIKULICZ TWO-STAGE OPERATION FOR PARTIAL COLOSTOMY

Gibson believes it is a *sine qua non* to have a long spur. If one can refrain from opening the gut for from four to six days, such a procedure practically serves as a guarantee of the wound healing without sloughing or other trouble.

DR. CHARLES H. PECK believed the two-stage procedure to be the safest in many cases, although he did not agree that it should be used in all cases, since one meets with a fair number of mobile cases where if there is no considerable amount of obstruction and distention one can do an immediate closure with impunity. He recalled five cases during the last few years in which an immediate suture was done. One was in carcinoma of the transverse colon where there was a water-tight obstruction; there was a fecal fistula opening in the small intestine through which the intestinal contents passed for a number of months. In this case there was a very satisfactory immediate healing with no leakage or abdominal wall infection. Recently he had had an extensive adenocarcinoma of the sigmoid quite mobile, with enlarged inflamed glands, which seemed suitable for immediate excision and suture; there resulted a sharp abdominal wall infection but no leakage, and the infection was controlled within a few days. The healing of the gut was immediate and the patient was out of bed almost completely healed in four weeks. In 1910 he had a case in which immediate suture was done, protecting the wound by a drain. Doctor Peck in this relation was speaking altogether of the transverse and descending colon and not including cases in the ileocaecal juncture and ascending colon; these are in a great measure one-stage operations. He referred to two further cases which healed after immediate suture. He believed there were a considerable number of cases sufficiently mobile where the gut was surrounded by enough peritoneum to warrant the one-stage operation. Here one can take a sufficient suture with cuffing over of one segment, protect it with adjacent fat or omentum, and thus be safe against intestinal leakage. He also believed that there are many cases in which the peritoneal covering was insufficient and where the danger of immediate closure was too great where the two-stage Mikulicz operation should be chosen.

DR. GEORGE WOOLSEY said that although he appreciated the value of the Mikulicz operation, he had always felt that if he could feel reasonably safe in a one-stage operation it had certain advantages. During the last several years he had seen a number of cases where the growth had not been acutely obstructing and where he had done the one-stage operation, though not always without slight local infection. He cited a case operated seven years ago for carcinoma of the descending colon where he had to open a small abscess in the loin, making a counter incision, with the patient well to-day; another case in the transverse colon was followed by no infection. He stated that in recent years he never had any leakage, which he considered due to the fact that he never does an end-

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to-end suture in the large intestine, always using a lateral anastomosis, which he considered safe. Formerly he had had leakage in end-to-end anastomosis.

DR. W. S. SCHLEY said that in reference to the immediate opening of the intestine in cases where there was obstruction, he felt it to be safe to use a large-calibre tube, suturing it into the proximal loop by two inverting purse-string sutures. In twenty-four hours peritoneum is quite tightly protected, and at the end of two or three days it is quite firm. He believes closure is easier at the end of four or five weeks after resection than at an earlier period, and safer.

DR. JOHN DOUGLAS, in closing, in regard to the remarks of Doctor Dowd and Doctor Peck, who stated that in cases of carcinoma of the ascending colon and hepatic flexure the Mikulicz operation was not indicated, but that here the one-stage operation was the one of choice, agreed that it was only where there was acute obstruction that the one-stage operation was contra-indicated. He believed that if in his reported case he had done the one-stage operation there would have been a fatal issue.

DR. CHARLES N. DOWD (in closing), in answer to Doctor Hartwell's query whether it was a simple matter to bring out the intestine, said that it was not always an easy procedure, but that it was sometimes very difficult. The division of the outer leaf of peritoneum, which runs outward from the descending colon, is a very great aid, and sometimes permits an astonishing degree of mobility. So far the difficulty in mobilizing the intestine had not forced him to do a one-stage operation when he wished to do the two-stage procedure.

In reference to a clamp he had found an ordinary Kocher clamp satisfactory. He usually selected an old one, not too strong, loose in the joint, with a long jaw and a long ratchet.

He wished to make himself clear as to the degree to which he advocates the Mikulicz operation. As expressed in the last paragraph of his paper, it was not his purpose to advocate the two-stage operation for all cases, but to urge its value in the average case as it comes to the hospital. With regard to the one-stage operation, he, too, had had his share of successes. He cited four consecutive cases where immediate suture resulted in good recovery, with temporary leakage in two. Then came the fifth case with a fatal result which made a great impression: it was a man with cancer of the transverse colon whose fat was largely absorbed and in whom a one-stage operation seemed indicated; he made an end-to-end anastomosis without difficulty and apparently with good prospect of success, but the patient died within a few days. Enough of an autopsy was obtained to show that the two ends of the intestine had become gangrenous and had fallen apart. Apparently infection had involved the site of the stitches, and had led to breaking down of the suture line and consequent peritonitis. He believed that this result would not have

#### RETENTION APPARATUS FOR HARELIP OPERATIONS

followed if the two-stage operation had been done and if the intestine had not been opened until the growth was exteriorized and the peritoneal cavity shut off.

#### RETENTION APPARATUS AFTER HARELIP OPERATIONS

DR. THEODORE DUNHAM stated that he had used various ways to hold the cheeks together in order to take the tension off and keep things at rest about the wound at harelip operations. The method which he now described answered better and promised better than any other method. He takes a piece of aluminum wire because it is very light; this is boiled with the instruments along with a pair of wire nippers and a file. He bends this wire, say about in the middle, so that it will have about the right curve to sit over the nose of the baby; he then bends two legs of it in a plane back to vertical to the plane in which the first bend was made, so that the two ends can come down alongside the nose. At the lower end just above the mouth he bends them straight up and cuts them off quite short to allow two little spurs at the end. He then wipes off the cheeks of the patient with alcohol and dries them, so that collodion will stick well, then takes a strip of silk muslin and passes it double around the end of the wire. Pressing the cheek up a little he fastens it with flexible collodion, following the same procedure on the opposite side. That allows the hairpin of wire to hold the cheeks together, thus taking the tension off the scar. He steadies the wire where it comes over the root of the nose by another piece of silk muslin fastened at the root of the nose and forehead. This little apparatus produced no apparent discomfort and had proven very satisfactory.

DR. WILLIAM A. DOWNES asked Doctor Dunham how often he found it necessary to use any type of appliance on harelips following operation, saying that, personally, he had used no appliance for the past four or five years. He called attention to Mr. James Berry's book on harelip and cleft palate in which it is stated that if there is a wide liberation of both sides of the lip there is practically never any necessity for a retention apparatus. Doctor Downes stated that he always used two layers of sutures, a catgut suture of chromic, including the mucous membrane and half the lip with the knot inside, then with a silk suture on the outside, including one-half the thickness of the lip.

DOCTOR DUNHAM, replying to Doctor Downes' question, said that he had always taken it for granted that the tension should be relieved by some method and therefore had never experimented without this in view.

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*Stated Meeting held December 1, 1919*

The President, DR. GEORGE G. ROSS, in the Chair

### USE OF FREE SKIN GRAFTS TO REPLACE LOSS OF MUCOUS MEMBRANE OF MOUTH AND NOSE

DR. GEORGE M. DORRANCE read a paper with the above title, for which see page 360.

DR. ROBERT H. IVY said as to the success of the skin grafts in the mouth, such grafts had been used at the Walter Reed Hospital in some types of cases in which there was loss of mucous membrane. He showed four slides, giving a general idea of the operation and the appliances used in connection with it. The first showed a wire splint attached to the teeth with a loop to carry the modelling compound down into the buccal sulcus after the adhesions had been divided. The next slide showed the temporary appliance replaced by an artificial denture after the graft had taken. Another slide showed one of the grafts in the mouth. This was a case in which the upper lip was bound down to the jaw bone. An artificial plate bearing teeth was made of vulcanite. The scar tissue was then divided and the plate with its upper edge covered with the Thiersch graft was inserted and retained in the mouth for several days, by which time the free skin had become adherent.

DR. JOHN B. ROBERTS said that in carrying Thiersch epithelial grafts into the mouth, one of the difficulties is getting the graft to fit perfectly against the surface. If there is air underneath the graft, it is apt to fail to live. The important thing is to first have a model made of the surface in modelling compound, or wax, as Doctor Dorrance has used. The compound at ordinary temperatures is hard; but by moistening it with warm water it softens and, pressing it down to the surface, there results an exact negative. The skin side of the graft is placed against the negative which is then pressed into place and fits every little detail of surface. The important thing is to get the raw surface of the epithelium pressed right down upon the place where it is wanted to adhere and grow fast. This applies also in the eye socket or in ectropion operations for burns. As Doctor Dorrance and Doctor Ivy have said, it is of the greatest importance to have perfect contact of the raw surface of the Thiersch graft with the raw surface. It is easy to see that quick union will take place if the parts are not disturbed.

DOCTOR DORRANCE, in closing, emphasized the fact that he made the cavity larger than he expected it to remain. The plate is not removed for

## FRACTURES OF THE PELVIS

three weeks after it is introduced. He particularly impressed this point also, because there have been many failures due to taking the plate out before this time.

## OPERATIVE TREATMENT OF UNUNITED FRACTURES OF THE MANDIBLE

DR. ROBERT H. IVY read a paper with the above title, for which see page 363.

DR. A. P. C. ASHHURST said that, while on duty at the Walter Reed Hospital, he had many opportunities to watch the work of Doctor Ivy and of his predecessors, and was very much impressed with the amount of improvement which can be obtained by the combination of prosthetic and surgical skill. It is a long and tedious process to get these jaws sufficiently aseptic for an operation; in the second place, to overcome any deformity that may be there, and then to secure union, the final stage of the operation. From what he saw at the Walter Reed Hospital and in other places it is evident that there has been a very great advance in surgery of this kind during the war.

DOCTOR IVY, in closing, said that in these cases he felt that he must sometimes feel the ends of the bone with his gloved fingers. He did not touch the graft with his fingers, but he did not see how it is possible to keep the fingers absolutely out of the jaw wound. He had had no experience with the rib graft, but had seen cases later in which the operation had been done by Doctor Dorrance with uniformly good results.

## FRACTURES OF THE PELVIS

DR. WILLIAM J. RYAN read a paper with the above title, for which see page 347.

DR. GEORGE G. ROSS said that fracture of the pelvis when the femur is driven into the acetabulum, or so-called central luxation, is not such an uncommon injury. It occurs in three degrees: First, when the floor of the acetabulum is split; second, when the head of the femur is through the acetabulum; third, where the entire head has entered the pelvic cavity and the neck rests on the fractured edge of the acetabulum. It occurs as a result of force applied to the great trochanter, transmitted through the neck. There were several instances of this fracture in the hospital at Brest, and they all occurred as a result of falls down hatchways or from smokestacks. Some years ago such an injury came to him at the Germantown Hospital. Altogether there were six lines of fractures of the pelvis; one being central, luxation of the second degree. This case was treated by a circular band of adhesive plaster, taking in the pelvis and making pressure on the great trochanter. The patient made a very satisfactory recovery and is able to walk without support and without a limp.

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DR. HENRY R. WHARTON expressed himself as much impressed with the high mortality in fractures of the pelvis mentioned by Doctor Ryan. His experience had been that the mortality of fractures of the pelvis, unless there are severe associated injuries, is rather low. He had seen cases recover in which there had been multiple fractures of the pelvic bones, with rupture of the bladder. He had recently under his care a case of fracture of the pubis, in which the patient had been caught between heavy pieces of iron and a wall, and in whom the urethra was torn from the bladder. Recovery occurred in this case after suprapubic cystotomy, retrograde catheterization, and perineal drainage. With regard to fracture of the pelvis in which the head of the femur is driven through the acetabulum, he had a case at the Presbyterian Hospital in which this occurred with other injuries in which the man made a good recovery. In this case, examination two years later showed that the patient walked easily and had no apparent shortening. With regard to the primary treatment, he had used a stout muslin binder, and, in some cases, plaster of Paris to immobilize the fracture. When the patient was able to get about he used a heavy canvas belt with straps and buckles to give good support in walking. He had been much impressed with the frequency of fracture of the pelvis in the last few years. It may be that routine X-ray examination discloses fracture of the pelvic bones formerly unsuspected.

DR. A. P. C. ASHHURST said that his experience agreed with what Doctor Wharton had said, that the mortality is not as high as the figures of Doctor Ryan would indicate, unless one considers only the cases diagnosed without the aid of skiagraphy. Looking up the records in the Episcopal Hospital about ten years ago, he found that the mortality was about 30 per cent. (*Trans. Phila. Acad. Surg.*, 1909, xi, 225), but within the last few years he doubted if it much exceeded 10 per cent. Thirteen years ago, when he wrote an article on rupture of the bladder, he called attention to the danger of overlooking rupture if one injects so small a quantity as one pint. While he was a resident physician at the Episcopal Hospital, Dr. Harry Deaver had a patient who had been injured in the abdomen. Doctor Ashhurst injected a pint of fluid into the bladder and all of it was recovered; nevertheless, at autopsy, an intraperitoneal rupture of the bladder was found. He made it a rule, therefore, to inject a quart; and sometimes even when one injects a quart, one may recover a quart and a half—showing that the fluid has gotten out of the bladder into the abdominal cavity, and that the catheter is draining the abdominal cavity. So that he has come to the conclusion that, unless the injected fluid causes the formation of a suprapubic tumor with the characteristics of a distended bladder, one cannot be sure the bladder is intact. He had come to the conclusion that in extraperitoneal rupture of the bladder, low down near its neck, it is safe to drain through the perineum. If there is a distinct rupture of the bladder easily found in the space of Retzius, one

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would naturally drain there; but he was sure it is safer, where the lesion is deep in the pelvis and extraperitoneal, also to drain through the perineum.

DR. GEORGE P. MULLER said that he had had two interesting experiences in connection with the diagnosis of rupture of the bladder by means of bladder injections. Several years ago, a patient was admitted to the University Hospital with the history of having been injured in the abdomen. A routine examination failed to show anything. He was catheterized and clear urine obtained; the interne stated that a measured amount of boric solution had been injected and recovered. Twenty-four hours later symptoms of peritonitis ensued and again he injected boric solution into the bladder and recovered the same amount. There was no blood. However, the abdomen was opened and a vertical tear in the bladder found exactly opposite the urethral orifice. They had been catheterizing the pelvic cavity. Recently, a case of fractured pelvis was admitted to the University Hospital, in which the symptoms of the ruptured bladder did not appear for twenty-four hours, at which time toxic symptoms were accompanied by a bulging mass above and to the right of the pubis. He had a tear in the bladder about  $\frac{1}{2}$  inch above the urethral orifice and opening into the space of Retzius.

From his observations of certain of the cases reported by Doctor Ryan, together with other cases, he believed it would be best if they would develop a method of drainage through the perineum. Doctor Wharton has spoken with surprise of the mortality. As he remembered the fatal cases, most of them died within an hour or two from shock caused by the associated injuries; the remainder occurred weeks after from slow sepsis. In connection with this mortality should be remembered Doctor Moschcowitz's remark that "statistics from memory are often lower than statistics from analysis of case records."

DOCTOR JOPSON said that in the examination of these cases the importance of rectal examination should never be overlooked, both for diagnostic purposes, and to determine whether injury of the rectum is present or threatened by the presence of spicula. In fractures of the rami of the pubis and ischium, there may be noted a reflex spasm of the adductor muscles of the thigh on the same side, as shown in movement of the thigh on the pelvis, which is of some diagnostic value. One of his former assistants, Dr. Douglas P. Murphy, devised an ingenious method of treatment for a case under their care, utilizing the principle of overhead extension. A heavy canvas sling, wide enough to include the entire pelvis and trochanters, was passed beneath the patient, a bar of corresponding length was passed through loops attached to the ends of the sling, and was attached in turn by cords to a longitudinal bar directly over the centre of the bed in a modified Balkan frame; the bar being only a short distance above the patient. In this manner the patient's pelvis was lifted clear of the bed, and the weight of his body furnished counter-pressure, which was conveyed through the sling to the sides of the pelvis

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and trochanters, pressing on them and effecting reduction and fixation of the vertically-separated fragments. This position was exceedingly comfortable, and the care and nursing of the patient were much simplified. The result was entirely satisfactory, and the method was a decided improvement over that which we were accustomed to use, *viz.*, circular compression and support by a heavy duck binder, fastened by straps and buckles, or pinned around the pelvis.

DR. D. B. PFEIFFER said that he saw a case this summer, in the service of Doctor Wharton in the Presbyterian Hospital, which illustrated the statement made by Doctor Ryan that certain cases need drainage in anticipation of suppuration, and the further report of one case which did show suppuration and sepsis presumably secondary to infection of a haematoma. The case referred to was a young man who had been brought to the hospital after an accident in which he had been struck by a trolley car while in an automobile and rendered unconscious. He soon regained consciousness and was brought to the hospital in an ambulance. He was placed in bed and examined by the interne, who found nothing alarming in his general condition but suspected an injury of the pelvis. The patient did not seem to be in pain. In a short time, however, he began to complain of pain in the lower abdomen, which became more and more severe. The temperature remained approximately normal, but the pulse rate had risen markedly, being about 140 per minute and of poor quality. The face was pale and the expression anxious. The abdominal muscles over the whole lower abdomen were tense and pressure was painful. Dullness over this area was pronounced. Any motion or disturbance of the pelvis was painful and it was concluded that a fracture existed. There was no blood in the urine. The probability of haematoma formation, as a cause of the general and local symptoms above stated, was considered. However, the intensity of the abdominal symptoms, together with the existence of a contused abrasion of the abdominal wall above the symphysis, suggested an intra-abdominal injury. The abdomen was opened through a right rectus incision. On splitting the fibres of the rectus, the preperitoneal tissue was seen to be infiltrated with a huge amount of blood which was for the most part held in the meshes of the areolar tissue. However, between the peritoneum and the region of the internal aspect of the acetabulum on the right side there was a cavity filled with approximately 250 to 300 c.c. of blood clot. This was evacuated and with the finger a complete fracture of the superior ramus of the pubis was felt. Active hemorrhage seemed to have ceased. The peritoneum was opened and no visceral injury found. The pelvic cavity was not more than half its normal size, due to the massive subperitoneal infiltration which surrounded it on all sides. A rubber tube was placed just through the abdominal wall into the preperitoneal space and the wound closed. Considerable serosanguinous exudate drained for three days, when the tube was removed. Healing and recovery were unevent-

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ful. It is probable that in this case there was a direct rupture of a vessel of considerable size, and while he would not have operated for this reason alone, there can be no doubt that the danger of infection of the haematoma was materially lessened by the evacuation of the clot and drainage of the preperitoneal space under all aseptic precautions.

DR. WALTER G. ELMER reported a rather unusual type of injury in a boy who was admitted to the Orthopaedic Department of the University Hospital for tuberculosis of the hip. X-ray examination revealed that the head of the bone had been driven through the floor of the acetabulum and tuberculosis of the hip had followed.

DOCTOR RYAN, in closing, remarked in regard to the mortality, which, according to Doctor Wharton and Doctor Ashurst, seems to be high, that three patients died within two hours of their admission, one in three hours and one in thirty hours.